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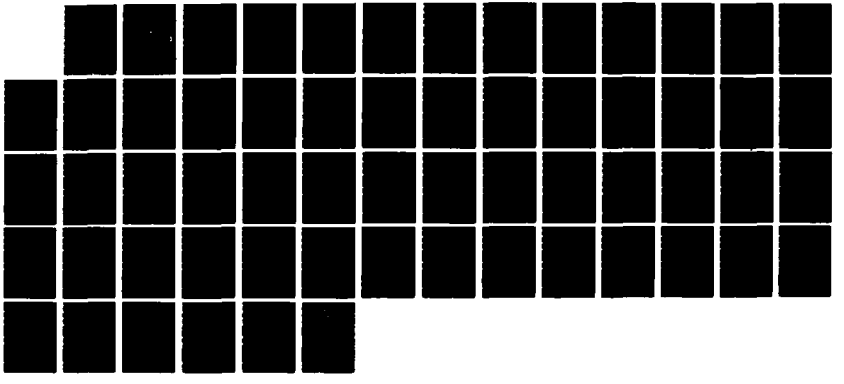

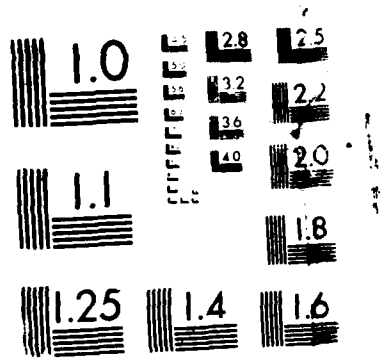

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NAVAL POSTGRADUATE SCHOOL

Monterey, California

SOLUTION OF THE LLOYD-MAX QUANTIZER PARAMETERS BY THE METHOD OF SUCCESSIVE SUBSTITUTION

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and

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SOLUTION OF THE LLOYD-MAX QUANTIZER PARAMETERS BY THE METHOD OF SUCCESSIVE SUBSTITUTION

Abstract

The method of successive substitution is shown applicable to solve for the classical minimum distortion quantizer parameters. The method is self converging and parameters can be calculated to any desired accuracy.

A. INTRODUCTION

The minimum distortion quantizer parameters [Ref. 2,1], as well as parameters based on other criterion such as quantizers for signal detection [Ref. 4], minimum risk quantizers and quantizers for LMMS estimation [Ref. 5] can be solved by Max's trial and error technique [Ref. 2]. There are also many other approximation methods to calculate the quantizer parameters [Refs. 6-8].

In this report we apply the method of successive substitution and its modifications [Ref. 3] to solve for the Lloyd-Max quantizer parameters. It is more accurate and computationally more efficient than the previously reported methods. It is shown to easily generate 7 bit (128 level) optimum quantization.

B. STATEMENT OF THE PROBLEM

The Lloyd-Max minimum mean square distortion quantizer problem deals with transforming a random variable X of differentiable probability density function f(x) into the N-level discrete random variable Y.

$$Y(X) = Y_i \text{ for } X \in [x_i, x_{i+1}] \qquad \text{(eqn 1.1)}$$

The optimum parameters minimize the distortion D

$$D = \sum_{i=1}^{N} \int_{x_i}^{x_{i+1}} (x-y_i)^2 f(x)\, dx \qquad \text{(eqn 1.2)}$$

with

$$-\infty = x_1 \le x_2 \le \ldots \le x_N \le x_{N+1} = \infty$$

Differentiating D with respect to x_i and y_i yields the following necessary conditions of optimality :

$$x_i = (y_i + y_{i+1})/2 \quad ,i = 2,3,...N \qquad \text{(eqn 1.3)}$$

$$y_i = (\int_{x_i}^{x_{i+1}} xf(x)dx)/(\int_{x_i}^{x_{i+1}} f(x)dx) \quad ,i = 1,2,..N \qquad \text{(eqn 1.4)}$$

a set of simultaneous equations of propagating character. That is, if y_1 is chosen correctly then x_2 can be calculated from (1.4), y_2 from (1.3), x_3 from (1.4) and so forth [Ref. 2]. In this case the value of y_N calculated from (1.3) must agree with its value calculated from (1.4) with $x_{N+1} = \infty$. This was the core of Max's trial and error algorithm: to pick a value for y_1 and calculate the parameters up to and including y_N , which must agree with the value of y_N calculated from (1.4), otherwise, to pick another value of y_1. Let us put the system of equations in the form

$$\underline{Z} = \underline{G}(\underline{Z}) \qquad \text{(eqn 1.5)}$$

where $\underline{Z}$ is a 2N-1 vector given by:

$$\underline{Z} = [\, y_1\ x_2\ y_2\ .....y_N\,]^t \qquad \text{(eqn 1.6)}$$

and apply the iterative substitution

$$\underline{Z}_{new} = \underline{G}(\underline{Z}_{old}) \qquad \text{(eqn 1.7)}$$

with a suitable initial guess. The convergence is guaranteed if $\partial G_k / \partial Z_j$ is sufficiently small for every k.j = 1,2,...,2N-1 [Ref. 3]. From (1.4)

$$\partial G_j / \partial y_j = [(x_{j+1} - y_j)f(x_{j+1}) + (y_j - x_j)f(x_j)] / (2P_j) \qquad \text{(eqn 1.8)}$$

where P_j is the probability the input of the quantizer is in the j_{th} interval.

$$P_j = \int_{x_j}^{x_{j+1}} f(x)dx. \qquad \text{(eqn 1.9)}$$

The numerator in (1.8) is an approximation of the integral in (1.9) by the trapezoidal rule with the subdivision $[x_j, y_j, x_{j+1}]$, so the value of the derivative is very likely less than one. Also, substituting for y_j and y_{j+1} in (1.3) from (1.4) and differentiating with respect to x_j it is easily to show that

$$\partial G_j / \partial x_j = (y_j - x_j) f(x_j)/(2P_j) + (x_j - y_{j-1}) f(x_j)/2P_{j-1} \qquad \text{(eqn 1.10)}$$

which is less than $(\partial G_j / \partial y_j)$. The method can be more efficient if we use the updated values in the same iteration. In this modification of the method the best current values of the parameters are used. This choice may also enhance convergence. The method also avoids the tedious calculation of the upper limit of the integral to solve for the next x_j in (1.4). A FORTRAN program is included as Appendix A.

C. NUMERICAL RESULTS.

We have solved for the quantizer parameters for a standard normal random variable of zero mean and unit variance for values of N up to 128. Also the mean square error D and the output entropy $(-\sum_k P_k \log_2 (P_k))$ have been calculated. The results presented in Table I show that in several cases Max's results, which were only available up to N = 36, are not accurate in the last digit.

Key to Table I

The numbering in the table is as follows:

1. For N even, each table begins with the $(N/2+1)_{th}$ parameters. In this case the $(N/2+1)_{th}$ value of x is zero.
2. For N odd, each table begins with the $(N/2+2)_{th}$ parameters. In this case the $(N/2+2)_{th}$ value of y is zero.

Negative parameters can be calculated from the symmetry relations

$$X_j = -X_{n-j+2} \qquad \text{(eqn 1.11)}$$

and

$$y_j = -y_{n-j+1}. \qquad \text{(eqn 1.12)}$$

TABLE 1

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION

N = 2

J	X	Y
2	0.000000	0.797885

ERROR = 0.363380
ENTROPY = 1.000000

N = 3

J	X	Y
2	-0.612003	0.000000
3	0.612003	1.224006

ERROR = 0.190174
ENTROPY = 1.535789

N = 4

J	X	Y
3	0.000000	0.452780
4	0.981599	1.510418

ERROR = 0.117482
ENTROPY = 1.911099

N = 5

J	X	Y
3	-0.382284	0.000000
4	0.382284	0.764567
5	1.244357	1.724147

ERROR = 0.079941
ENTROPY = 2.202916

N = 6

J	X	Y
4	0.000000	0.317716
5	0.658911	1.000106
6	1.446850	1.893595

ERROR = 0.057978
ENTROPY = 2.442789

N = 7

J	X	Y
4	-0.280289	0.000000
5	0.280288	0.560577
6	0.874362	1.188147
7	1.610758	2.033369

ERROR = 0.044000

ENTROPY = 2.646931

N = 8

J	X	Y
5	0.000000	0.245094
6	0.500550	0.756005
7	1.049957	1.343909
8	1.747927	2.151946

ERROR = 0.034548
ENTROPY = 2.824865

N = 9

J	X	Y
5	-0.221819	0.000000
6	0.221819	0.443639
7	0.681217	0.918796
8	1.197594	1.476392
9	1.865528	2.254664

ERROR = 0.027853
ENTROPY = 2.982695

N = 10

J	X	Y
6	0.000000	0.199623
7	0.404740	0.609857
8	0.833841	1.057825
9	1.324583	1.591340
10	1.968218	2.345096

ERROR = 0.022937
ENTROPY = 3.124584

N = 11

J	X	Y
6	-0.183729	0.000000
7	0.183729	0.367458
8	0.559913	0.752367
9	0.965597	1.178826
10	1.435733	1.692639
11	2.059193	2.425746

ERROR = 0.019220
ENTROPY = 3.253506

N = 12

J	X	Y
7	0.000000	0.168438
8	0.340142	0.511846
9	0.694313	0.876779
10	1.081245	1.285711
11	1.534371	1.783030
12	2.140733	2.498435

ERROR = 0.016340
ENTROPY = 3.371666

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 13

J	X	Y
7	-0.156887	0.000000
8	0.156887	0.313773
9	0.476012	0.638251
10	0.812600	0.986949
11	1.184106	1.381263
12	1.622890	1.864518
13	2.214522	2.564525

ERROR = 0.014063
ENTROPY = 3.480744

N = 14

J	X	Y
8	0.000000	0.145706
9	0.293513	0.441321
10	0.595882	0.750443
11	0.918039	1.085635
12	1.276582	1.467528
13	1.703070	1.938612
14	2.281837	2.625062

ERROR = 0.012232
ENTROPY = 3.582050

N = 15

J	X	Y
8	-0.136929	0.000000
9	0.136928	0.273857
10	0.414310	0.554764
11	0.702949	0.851134
12	1.013007	1.174879
13	1.360468	1.546057
14	1.776266	2.006474
15	2.343670	2.680866

ERROR = 0.010737
ENTROPY = 3.676630

N = 16

J	X	Y
9	0.000000	0.128395
10	0.258222	0.388048
11	0.522404	0.656759
12	0.799550	0.942340
13	1.099286	1.256231
14	1.437139	1.618046
15	1.843532	2.069017
16	2.400803	2.732590

ERROR = 0.009501
ENTROPY = 3.765328

N = 17

J	X	Y
9	-0.121497	0.000000
10	0.121497	0.242994
11	0.366938	0.490882
12	0.620085	0.749287
13	0.887442	1.025597
14	1.178246	1.330896
15	1.507669	1.684442
16	1.905707	2.126971
17	2.453866	2.780762

ERROR = 0.008467
ENTROPY = 3.848840

N = 18

J	X	Y
10	0.000000	0.114769
11	0.230557	0.346345
12	0.465324	0.584302
13	0.709082	0.833862
14	0.967981	1.102100
15	1.250963	1.399827
16	1.572915	1.746003
17	1.963465	2.180927
18	2.503372	2.825817

ERROR = 0.007593
ENTROPY = 3.927741

N = 19

J	X	Y
10	-0.109205	0.000000
11	0.109204	0.218409
12	0.329382	0.440355
13	0.555076	0.669797
14	0.790731	0.911666
15	1.042234	1.172801
16	1.318296	1.463791
17	1.633568	1.803345
18	2.017359	2.231373
19	2.549745	2.868116

ERROR = 0.006848
ENTROPY = 4.002518

TABLE 1

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 20

J	X	Y
11	0.000000	0.103762
12	0.208277	0.312791
13	0.419640	0.526488
14	0.637511	0.748533
15	0.866088	0.983642
16	1.111055	1.238467
17	1.380941	1.523414
18	1.690196	1.856977
19	2.067846	2.278714
20	2.593337	2.907961

ERROR = 0.006208
ENTROPY = 4.073583

N = 21

J	X	Y
11	-0.099179	0.000000
12	0.099178	0.198357
13	0.298856	0.399355
14	0.502624	0.605892
15	0.713667	0.821442
16	0.935997	1.050552
17	1.175138	1.299725
18	1.439469	1.579214
19	1.743269	1.907323
20	2.115306	2.323289
21	2.634448	2.945607

ERROR = 0.005653
ENTROPY = 4.141290

N = 22

J	X	Y
12	0.000000	0.094686
13	0.189942	0.285198
14	0.382215	0.479232
15	0.579359	0.679485
16	0.784380	0.889276
17	1.001147	1.113019
18	1.235056	1.357093
19	1.494358	1.631622
20	1.793180	1.954739
21	2.160062	2.365386
22	2.673330	2.981274

ERROR = 0.005170
ENTROPY = 4.205942

N = 23

J	X	Y
12	-0.090844	0.000000
13	0.090844	0.181688
14	0.273544	0.365400
15	0.459363	0.553325
16	0.650668	0.748012
17	0.850333	0.952654
18	1.062107	1.171561
19	1.291284	1.411007
20	1.546005	1.681003
21	1.840265	1.999527
22	2.202390	2.405252
23	2.710201	3.015150

ERROR = 0.004746
ENTROPY = 4.267806

N = 24

J	X	Y
13	0.000000	0.087072
14	0.174587	0.262101
15	0.350977	0.439853
16	0.531112	0.622370
17	0.717227	0.812084
18	0.912088	1.012091
19	1.119352	1.226612
20	1.344223	1.461834
21	1.594750	1.727666
22	1.884807	2.041948
23	2.242523	2.443098
24	2.745248	3.047398

ERROR = 0.004372
ENTROPY = 4.327112

N = 25

J	X	Y
13	-0.083805	0.000000
14	0.083805	0.167610
15	0.252208	0.336806
16	0.423045	0.509283
17	0.598128	0.686972
18	0.779592	0.872212
19	0.970115	1.068019
20	1.173279	1.278540
21	1.394213	1.509886
22	1.640881	1.771876
23	1.927050	2.082224
24	2.280667	2.479110
25	2.778634	3.078159

ERROR = 0.004041
ENTROPY = 4.384064

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 26

J	X	Y
14	0.000000	0.080593
15	0.161536	0.242480
16	0.324498	0.406516
17	0.490402	0.574288
18	0.660961	0.747635
19	0.838229	0.928823
20	1.024813	1.120803
21	1.224230	1.327657
22	1.441544	1.555432
23	1.684648	1.813865
24	1.967207	2.120549
25	2.316997	2.513445
26	2.810502	3.107559

ERROR = 0.003746
ENTROPY = 4.438843

N = 27

J	X	Y
14	-0.077781	0.000000
15	0.077780	0.155561
16	0.233975	0.312389
17	0.392106	0.471823
18	0.553594	0.635364
19	0.720073	0.804782
20	0.893532	0.982291
21	1.076518	1.170756
22	1.272495	1.374235
23	1.486469	1.598704
24	1.726267	1.853829
25	2.005461	2.157093
26	2.351670	2.546247
27	2.840977	3.135707

ERROR = 0.003483
ENTROPY = 4.491610

N = 28

J	X	Y
15	0.000000	0.075012
16	0.150307	0.225602
17	0.301760	0.377919
18	0.455569	0.533219
19	0.613076	0.692934
20	0.775854	0.858775
21	0.945836	1.032897
22	1.125522	1.218147
23	1.318326	1.418505
24	1.529205	1.639905
25	1.765925	1.891945
26	2.041975	2.192005
27	2.384821	2.577637
28	2.870169	3.162701

ERROR = 0.003246
ENTROPY = 4.542507

N = 29

J	X	Y
15	-0.072566	0.000000
16	0.072566	0.145132
17	0.218211	0.291291
18	0.365424	0.439557
19	0.515338	0.591119
20	0.669236	0.747352
21	0.828638	0.909923
22	0.995431	1.080939
23	1.172074	1.263209
24	1.361940	1.460671
25	1.569941	1.679211
26	1.803788	1.928364
27	2.076890	2.225415
28	2.416571	2.607727
29	2.898177	3.188627

ERROR = 0.003032
ENTROPY = 4.591663

N = 30

J	X	Y
16	0.000000	0.070155
17	0.140542	0.211[illegible]
18	0.282019	0.353[illegible]
19	0.425[illegible]	0.4[illegible]
20	0.571[illegible]	0.[illegible]
21	0.722402	0.[illegible]
22	0.878709	0.[illegible]
23	1.042565	1.[illegible]
24	1.216393	1.[illegible]
25	1.403530	1.[illegible]
26	1.608846	1.[illegible]
27	1.840001	1.[illegible]
28	2.110332	2.[illegible]
29	2.447027	2.[illegible]
30	2.925088	3.213562

ERROR = 0.002839
ENTROPY = 4.639193

TABLE 1

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 31

J	X	Y
16	-0.068008	0.000000
17	0.068008	0.136016
18	0.204446	0.272876
19	0.342170	0.411464
20	0.482101	0.552739
21	0.625267	0.697794
22	0.772858	0.847921
23	0.926315	1.004710
24	1.087456	1.170202
25	1.258670	1.347138
26	1.443261	1.539385
27	1.646065	1.752745
28	1.874694	1.996643
29	2.142413	2.288184
30	2.476285	2.664385
31	2.950981	3.237577

ERROR = 0.002664
ENTROPY = 4.685201

N = 32

J	X	Y
17	0.000000	0.065890
13	0.131971	0.198052
19	0.264715	0.331378
20	0.399039	0.466699
21	0.535816	0.604934
22	0.676035	0.747136
23	0.820850	0.894565
24	0.971674	1.048783
25	1.130294	1.211804
26	1.299072	1.386340
27	1.481284	1.576228
28	1.681731	1.787233
29	1.907981	2.028728
30	2.173234	2.317739
31	2.504429	2.691120
32	2.975926	3.260732

ERROR = 0.002505
ENTROPY = 4.729784

N = 33

J	X	Y
17	-0.063990	0.000000
18	0.063989	0.127979
19	0.192320	0.256661
20	0.321719	0.386777
21	0.452946	0.519114
22	0.586835	0.654557
23	0.724342	0.794128
24	0.866594	0.939060
25	1.014974	1.090888
26	1.171246	1.251604
27	1.337749	1.423893
28	1.517729	1.611565
29	1.715958	1.820352
30	1.939964	2.059577
31	2.202883	2.346189
32	2.531538	2.716887
33	2.999987	3.283086

ERROR = 0.002359
ENTROPY = 4.773025

N = 34

J	X	Y
18	0.000000	0.062113
19	0.124387	0.186661
20	0.249422	0.312182
21	0.375774	0.439366
22	0.504166	0.568966
23	0.635400	0.701834
24	0.770402	0.838970
25	0.910276	0.981581
26	1.056382	1.131182
27	1.210461	1.289741
28	1.374831	1.459921
29	1.552714	1.645507
30	1.748853	1.852198
31	1.970736	2.089274
32	2.231441	2.373609
33	2.557680	2.741751
34	3.023220	3.304689

ERROR = 0.002226
ENTROPY = 4.815004

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 35

J	X	Y
18	-0.060420	0.000000
19	0.060420	0.120840
20	0.181556	0.242272
21	0.303590	0.364907
22	0.427154	0.489401
23	0.552939	0.616478
24	0.681721	0.746965
25	0.814402	0.881839
26	0.952063	1.022287
27	1.096045	1.169804
28	1.248071	1.326339
29	1.410437	1.494535
30	1.586344	1.678153
31	1.780507	1.882861
32	2.000379	2.117898
33	2.258981	2.400065
34	2.582918	2.765771
35	3.045679	3.325587

ERROR = 0.002104
ENTROPY = 4.855793

N = 36

J	X	Y
19	0.000000	0.058747
20	0.117630	0.176512
21	0.235806	0.295100
22	0.355094	0.415088
23	0.476096	0.537104
24	0.599475	0.661847
25	0.725985	0.790123
26	0.856506	0.922889
27	0.992102	1.061315
28	1.134096	1.206878
29	1.284194	1.361509
30	1.444672	1.527835
31	1.618713	1.709591
32	1.811006	1.912420
33	2.028969	2.145518
34	2.285569	2.425621
35	2.607309	2.788998
36	3.067411	3.345823

ERROR = 0.001991
ENTROPY = 4.895457

N = 37

J	X	Y
19	-0.057229	0.000000
20	0.057228	0.114457
21	0.171937	0.229416
22	0.287406	0.345396
23	0.404171	0.462946
24	0.522808	0.582670
25	0.643958	0.705246
26	0.768354	0.831462
27	0.896860	0.962258
28	1.030524	1.098789
29	1.170652	1.242515
30	1.318934	1.395353
31	1.477631	1.559910
32	1.649906	1.739903
33	1.840425	1.940946
34	2.056573	2.172199
35	2.311265	2.450331
36	2.630905	2.811480
37	3.088458	3.365436

ERROR = 0.001888
ENTROPY = 4.934058

N = 38

J	X	Y
20	0.000000	0.055727
21	0.111570	0.167413
22	0.223606	0.279799
23	0.336588	0.393377
24	0.451025	0.508673
25	0.567472	0.626270
26	0.686549	0.746829
27	0.808975	0.871121
28	0.935596	1.000071
29	1.067445	1.134820
30	1.205818	1.276815
31	1.352387	1.427958
32	1.509400	1.590841
33	1.680000	1.769160
34	1.868833	1.968505
35	2.083252	2.197998
36	2.336122	2.474247
37	2.653754	2.833261
38	3.108861	3.384461

ERROR = 0.001792
ENTROPY = 4.971649

TABLE 1

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 39

J	X	Y
20	-0.054358	0.000000
21	0.054357	0.108715
22	0.163288	0.217860
23	0.272869	0.327878
24	0.383557	0.439236
25	0.495838	0.552440
26	0.610249	0.668057
27	0.727394	0.786731
28	0.847976	0.909220
29	0.972828	1.036437
30	1.102972	1.169508
31	1.239688	1.309869
32	1.384639	1.459408
33	1.540055	1.620702
34	1.709065	1.797429
35	1.896293	1.995157
36	2.109062	2.222968
37	2.360191	2.497415
38	2.675898	2.854381
39	3.128656	3.402931

ERROR = 0.001703
ENTROPY = 5.008284

N = 40

J	X	Y
21	0.000000	0.053003
22	0.106105	0.159207
23	0.212610	0.266014
24	0.319929	0.373842
25	0.428491	0.483140
26	0.538769	0.594398
27	0.651282	0.708166
28	0.766620	0.825075
29	0.885473	0.945871
30	1.008663	1.071455
31	1.137199	1.202942
32	1.272350	1.341757
33	1.415766	1.489775
34	1.569667	1.649539
35	1.737165	1.824771
36	1.922862	2.020954
37	2.134056	2.247159
38	2.383518	2.519877
39	2.697377	2.874878
40	3.147876	3.420875

ERROR = 0.001621
ENTROPY = 5.044010

N = 41

J	X	Y
21	-0.051761	0.000000
22	0.051761	0.103522
23	0.155469	0.207416
24	0.259739	0.312062
25	0.364961	0.417860
26	0.471551	0.525241
27	0.579961	0.634681
28	0.690699	0.746717
29	0.804344	0.861970
30	0.921571	0.981172
31	1.043194	1.105216
32	1.170210	1.235205
33	1.303880	1.372554
34	1.445841	1.519128
35	1.598301	1.677474
36	1.764357	1.851240
37	1.948594	2.045947
38	2.158280	2.270613
39	2.406144	2.541674
40	2.718229	2.894784
41	3.166553	3.438322

ERROR = 0.001545
ENTROPY = 5.078870

N = 42

J	X	Y
22	0.000000	0.050532
23	0.101151	0.151770
24	0.202649	0.253528
25	0.304849	0.356170
26	0.408125	0.460079
27	0.512875	0.565671
28	0.619541	0.673410
29	0.728616	0.783821
30	0.840668	0.897514
31	0.956364	1.015213
32	1.076507	1.137800
33	1.202085	1.266370
34	1.334349	1.402327
35	1.474926	1.547526
36	1.626014	1.704502
37	1.790695	1.876887
38	1.973535	2.070182
39	2.181777	2.293372
40	2.428107	2.562841
41	2.738486	2.914131
42	3.184714	3.455297

ERROR = 0.001474
ENTROPY = 5.112906

TABLE 1

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 43

J	X	Y
22	-0.049402	0.000000
23	0.049402	0.098804
24	0.148367	0.197930
25	0.247820	0.297709
26	0.348098	0.398487
27	0.449560	0.500632
28	0.552591	0.604551
29	0.657622	0.710693
30	0.765133	0.819574
31	0.875685	0.931797
32	0.989936	1.048075
33	1.108678	1.169281
34	1.232893	1.296504
35	1.363821	1.431138
36	1.503082	1.575026
37	1.652860	1.730694
38	1.816226	1.901759
39	1.997729	2.093700
40	2.204587	2.315474
41	2.449443	2.583412
42	2.758180	2.932948
43	3.202386	3.471824

ERROR = 0.001407
ENTROPY = 5.146156

N = 44

J	X	Y
23	0.000000	0.048282
24	0.096640	0.144997
25	0.193582	0.242167
26	0.291136	0.340105
27	0.389624	0.439143
28	0.489391	0.539639
29	0.590812	0.641986
30	0.694306	0.746626
31	0.800346	0.854066
32	0.909482	0.964898
33	1.022364	1.079830
34	1.139779	1.199727
35	1.262698	1.325669
36	1.392355	1.459041
37	1.530360	1.601679
38	1.678888	1.756097
39	1.840997	1.925897
40	2.021218	2.116539
41	2.226746	2.336952
42	2.470185	2.603417
43	2.777339	2.951262
44	3.219593	3.487924

ERROR = 0.001345
ENTROPY = 5.178655

N = 45

J	X	Y
23	-0.047248	0.000000
24	0.047248	0.094497
25	0.141886	0.189276
26	0.236950	0.284625
27	0.332735	0.380845
28	0.429551	0.478256
29	0.527730	0.577204
30	0.627639	0.678074
31	0.729686	0.781298
32	0.834337	0.887375
33	0.942134	0.996892
34	1.053719	1.110547
35	1.169873	1.229199
36	1.291560	1.353920
37	1.420005	1.486090
38	1.556811	1.627533
39	1.704143	1.780753
40	1.865047	1.949341
41	2.044038	2.138736
42	2.248288	2.357840
43	2.490362	2.622884
44	2.795991	2.969098
45	3.236358	3.503619

ERROR = 0.001287
ENTROPY = 5.210437

N = 46

J	X	Y
24	0.000000	0.046224
25	0.092514	0.138804
26	0.185294	0.231783
27	0.278609	0.325435
28	0.372741	0.420048
29	0.467990	0.515932
30	0.564679	0.613425
31	0.663163	0.712902
32	0.763845	0.814788
33	0.867182	0.919576
34	0.973710	1.027844
35	1.084065	1.140286
36	1.199020	1.257753
37	1.319532	1.381311
38	1.446821	1.512331
39	1.582481	1.652630
40	1.728667	1.804704
41	1.888415	1.972127
42	2.066225	2.160324
43	2.269245	2.378167
44	2.510004	2.641842
45	2.814160	2.986478
46	3.252702	3.518926

ERROR = 0.001233
ENTROPY = 5.241533

TABLE 1

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION

N = 47

J	X	Y
24	-0.045275	0.000000
25	0.045275	0.090550
26	0.135949	0.181348
27	0.226998	0.272648
28	0.318680	0.364712
29	0.411265	0.457818
30	0.505042	0.552267
31	0.600327	0.648388
32	0.697469	0.746549
33	0.796860	0.847170
34	0.898953	0.950735
35	1.004276	1.057817
36	1.113461	1.169104
37	1.227273	1.285441
38	1.346664	1.407887
39	1.472848	1.537808
40	1.607410	1.677012
41	1.752498	1.827984
42	1.911136	1.994289
43	2.087810	2.181332
44	2.289646	2.397960
45	2.529136	2.660313
46	2.831868	3.003424
47	3.268645	3.533865

ERROR = 0.001182
ENTROPY = 5.271972

N = 48

J	X	Y
25	0.000000	0.044334
26	0.088727	0.133119
27	0.177688	0.222256
28	0.267121	0.311985
29	0.357273	0.402560
30	0.448405	0.494250
31	0.540798	0.587346
32	0.634759	0.682172
33	0.730630	0.779089
34	0.828799	0.878509
35	0.929711	0.980913
36	1.033889	1.086866
37	1.141959	1.197052
38	1.254681	1.312310
39	1.373002	1.433693
40	1.498127	1.562561
41	1.631638	1.700715
42	1.775672	1.850629
43	1.933243	2.015857
44	2.108823	2.201789
45	2.309518	2.417246
46	2.547783	2.678320
47	2.849138	3.019956
48	3.284204	3.548451

ERROR = 0.001134
ENTROPY = 5.301780

N = 49

J	X	Y
25	-0.043460	0.000000
26	0.043460	0.086920
27	0.130490	0.174059
28	0.217851	0.261642
29	0.305770	0.349899
30	0.394487	0.439074
31	0.484252	0.529429
32	0.575339	0.621249
33	0.668049	0.714849
34	0.762718	0.810586
35	0.859726	0.908866
36	0.959515	1.010164
37	1.062603	1.115042
38	1.169610	1.224177
39	1.281291	1.338404
40	1.398587	1.458770
41	1.522699	1.586628
42	1.655200	1.723772
43	1.798221	1.872670
44	1.954766	2.036862
45	2.129292	2.221723
46	2.328885	2.436047
47	2.565967	2.695886
48	2.865990	3.036093
49	3.299397	3.562701

ERROR = 0.001089
ENTROPY = 5.330984

N = 50

J	X	Y
26	0.000000	0.042593
27	0.085238	0.127883
28	0.170683	0.213483
29	0.256546	0.299609
30	0.343046	0.386482
31	0.430411	0.474339
32	0.518887	0.563434
33	0.608740	0.654046
34	0.700265	0.746485
35	0.793793	0.841101
36	0.889699	0.938297
37	0.988420	1.038542
38	1.090468	1.142393
39	1.196459	1.250524
40	1.307144	1.363763
41	1.423458	1.483154
42	1.546598	1.610042
43	1.678130	1.746217
44	1.820177	1.894136
45	1.975733	2.057330
46	2.149243	2.241156
47	2.347771	2.454386
48	2.583709	2.713031
49	2.882442	3.051853
50	3.314240	3.576627

ERROR = 0.001047
ENTROPY = 5.359608

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 51			N = 52		
J	X	Y	J	X	Y
26	-0.041785	0.000000	27	0.000000	0.040984
27	0.041785	0.083570	28	0.082013	0.123043
28	0.125453	0.167335	29	0.164211	0.205379
29	0.209414	0.251494	30	0.246781	0.288182
30	0.293872	0.336250	31	0.329916	0.371650
31	0.379035	0.421820	32	0.413820	0.455989
32	0.465126	0.508433	33	0.498707	0.541425
33	0.552384	0.596336	34	0.584812	0.628199
34	0.641069	0.685803	35	0.672389	0.716579
35	0.731471	0.777139	36	0.761723	0.806867
36	0.823914	0.870690	37	0.853135	0.899402
37	0.918771	0.966852	38	0.946991	0.994580
38	1.016473	1.066093	39	1.043720	1.092860
39	1.117528	1.168963	40	1.143826	1.194792
40	1.222548	1.276133	41	1.247916	1.301040
41	1.332279	1.388425	42	1.356732	1.412425
42	1.447652	1.506880	43	1.471202	1.529980
43	1.569858	1.632837	44	1.592511	1.655042
44	1.700458	1.768079	45	1.722213	1.789384
45	1.841567	1.915055	46	1.862418	1.935451
46	1.996170	2.077285	47	2.016101	2.096751
47	2.168698	2.260112	48	2.187682	2.278613
48	2.366199	2.472285	49	2.384188	2.489762
49	2.601028	2.729772	50	2.617944	2.746127
50	2.898511	3.067251	51	2.914215	3.082303
51	3.328748	3.590245	52	3.342935	3.603567
	ERROR =	0.001007		ERROR =	0.000969
	ENTROPY =	5.387674		ENTROPY =	5.415203

TABLE 1

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 53		
J	X	Y
27	-0.040235	0.000000
28	0.040234	0.080469
29	0.120790	0.161112
30	0.201609	0.242106
31	0.282869	0.323633
32	0.364758	0.405884
33	0.447472	0.489060
34	0.531220	0.573381
35	0.616232	0.659083
36	0.702756	0.746430
37	0.791074	0.835719
38	0.881502	0.927286
39	0.974404	1.021522
40	1.070203	1.118884
41	1.169400	1.219917
42	1.272599	1.325281
43	1.380538	1.435794
44	1.494140	1.552485
45	1.614584	1.676684
46	1.743422	1.810160
47	1.882755	1.955349
48	2.035550	2.115751
49	2.206215	2.296678
50	2.401757	2.506836
51	2.634474	2.762113
52	2.929568	3.097023
53	3.356814	3.616605
ERROR =		0.000934
ENTROPY =		5.442216

N = 54		
J	X	Y
28	0.000000	0.039491
29	0.079024	0.118556
30	0.158213	0.197869
31	0.237734	0.277599
32	0.317760	0.357922
33	0.398472	0.439022
34	0.480059	0.521097
35	0.562728	0.604359
36	0.646700	0.689042
37	0.732224	0.775405
38	0.819574	0.863742
39	0.909063	0.954384
40	1.001052	1.047720
41	1.095961	1.144202
42	1.194287	1.244373
43	1.296631	1.348889
44	1.403726	1.458564
45	1.516493	1.574422
46	1.636105	1.697789
47	1.764109	1.830430
48	1.902601	1.974772
49	2.054538	2.134304
50	2.224315	2.314327
51	2.418925	2.523524
52	2.650634	2.777745
53	2.944585	3.111426
54	3.370398	3.629370
ERROR =		0.000900
ENTROPY =		5.468732

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 55		
J	X	Y
28	-0.038795	0.000000
29	0.038795	0.077590
30	0.116463	0.155336
31	0.194366	0.233396
32	0.272665	0.311934
33	0.351526	0.391118
34	0.431123	0.471128
35	0.511643	0.552158
36	0.593286	0.634414
37	0.676270	0.718127
38	0.760839	0.803552
39	0.847265	0.890979
40	0.935858	0.980737
41	1.026974	1.073210
42	1.121030	1.168849
43	1.218521	1.268192
44	1.320042	1.371893
45	1.426327	1.480761
46	1.538289	1.595817
47	1.657099	1.718382
48	1.784299	1.850216
49	1.921977	1.993738
50	2.073084	2.152429
51	2.242003	2.331577
52	2.435709	2.539841
53	2.666439	2.793037
54	2.959280	3.125523
55	3.383698	3.641873
ERROR =		0.000868
ENTROPY =		5.494769

N = 56		
J	X	Y
29	0.000000	0.038104
30	0.076245	0.114386
31	0.152638	0.190890
32	0.229329	0.267769
33	0.306474	0.345179
34	0.384232	0.423285
35	0.462773	0.502261
36	0.542279	0.582297
37	0.622946	0.663595
38	0.704989	0.746383
39	0.788648	0.830913
40	0.874191	0.917470
41	0.961926	1.006382
42	1.052205	1.098028
43	1.145443	1.192857
44	1.242131	1.291405
45	1.342863	1.394321
46	1.448366	1.502411
47	1.559553	1.616694
48	1.677590	1.738486
49	1.804013	1.869539
50	1.940904	2.012269
51	2.091207	2.170146
52	2.259295	2.348444
53	2.452124	2.555804
54	2.681904	2.808004
55	2.973665	3.139327
56	3.396725	3.654124
ERROR =		0.000838
ENTROPY =		5.520344

TABLE 1

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 57			N = 58		
J	X	Y	J	X	Y
29	-0.037455	0.000000	30	0.000000	0.036811
30	0.037455	0.074910	31	0.073655	0.110499
31	0.112435	0.149960	32	0.147443	0.184388
32	0.187627	0.225293	33	0.221501	0.258614
33	0.263174	0.301055	34	0.295966	0.333318
34	0.339226	0.377398	35	0.370983	0.408647
35	0.415939	0.454480	36	0.446703	0.484758
36	0.493477	0.532474	37	0.523288	0.561817
37	0.572019	0.611564	38	0.600911	0.640004
38	0.651756	0.691949	39	0.679761	0.719519
39	0.732902	0.773854	40	0.760049	0.800579
40	0.815691	0.857527	41	0.842006	0.883433
41	0.900390	0.943252	42	0.925896	0.968359
42	0.987302	1.031352	43	1.012020	1.055681
43	1.076779	1.122205	44	1.100726	1.145772
44	1.169231	1.216257	45	1.192423	1.239075
45	1.265148	1.314039	46	1.287597	1.336120
46	1.365119	1.416199	47	1.386836	1.437552
47	1.469870	1.523541	48	1.490862	1.544[illegible]
48	1.580309	1.637077	49	1.600579	1.656988
49	1.697599	1.758121	50	1.717147	1.777307
50	1.823270	1.888420	51	1.842092	1.906876
51	1.959401	2.030382	52	1.977486	2.048095
52	2.108926	2.187470	53	2.126256	2.204417
53	2.276207	2.364944	54	2.292755	2.381092
54	2.468185	2.571426	55	2.483906	2.586720
55	2.697042	2.822658	56	2.711865	2.837011
56	2.987753	3.152848	57	3.001555	3.166099
57	3.409491	3.666133	58	3.422003	3.677908
	ERROR =	0.000809		ERROR =	0.000782
	ENTROPY =	5.545472		ENTROPY =	5.570170

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 59		
J	X	Y
30	-0.036205	0.000000
31	0.036204	0.072409
32	0.108677	0.144945
33	0.181340	0.217736
34	0.254325	0.290914
35	0.327764	0.364614
36	0.401798	0.438982
37	0.476574	0.514167
38	0.552251	0.590335
39	0.628998	0.667661
40	0.707002	0.746343
41	0.786469	0.826595
42	0.867629	0.908663
43	0.950744	0.992824
44	1.036111	1.079398
45	1.124077	1.168756
46	1.215047	1.261339
47	1.309506	1.357674
48	1.408038	1.458403
49	1.511363	1.564324
50	1.620383	1.676442
51	1.736253	1.796064
52	1.860495	1.924926
53	1.995175	2.065424
54	2.143214	2.221004
55	2.308953	2.396902
56	2.499301	2.601700
57	2.726387	2.851074
58	3.015081	3.179083
59	3.434273	3.689458
ERROR =		0.000756
ENTROPY =		5.594452

N = 60		
J	X	Y
31	0.000000	0.035602
32	0.071235	0.106868
33	0.142591	0.178315
34	0.214191	0.250066
35	0.286158	0.322250
36	0.358624	0.394997
37	0.431723	0.468449
38	0.505601	0.542753
39	0.580411	0.618069
40	0.656321	0.694574
41	0.733516	0.772458
42	0.812197	0.851936
43	0.892593	0.933251
44	0.974964	1.016676
45	1.059603	1.102530
46	1.146857	1.191183
47	1.237127	1.283072
48	1.330897	1.378722
49	1.428748	1.478773
50	1.531396	1.584019
51	1.639741	1.695464
52	1.754936	1.814408
53	1.878496	1.942585
54	2.012484	2.082384
55	2.159813	2.237243
56	2.324814	2.412386
57	2.514381	2.616377
58	2.740618	2.864858
59	3.028342	3.191826
60	3.446309	3.700791
ERROR =		0.000732
ENTROPY =		5.618331

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 61			N = 62		
J	X	Y	J	X	Y
31	-0.035035	0.000000	32	0.000000	0.034471
32	0.035035	0.070070	33	0.068970	0.103468
33	0.105162	0.140254	34	0.138049	0.172630
34	0.175462	0.210670	35	0.207349	0.242068
35	0.246053	0.281436	36	0.276983	0.311897
36	0.317056	0.352675	37	0.347067	0.382238
37	0.388595	0.424516	38	0.417726	0.453214
38	0.460805	0.497094	39	0.489087	0.524960
39	0.533826	0.570557	40	0.561289	0.597618
40	0.607809	0.645061	41	0.634481	0.671344
41	0.682919	0.720778	42	0.708826	0.746307
42	0.759338	0.797898	43	0.784501	0.822695
43	0.837266	0.876634	44	0.861707	0.900718
44	0.916929	0.957225	45	0.940666	0.980613
45	0.998584	1.039944	46	1.021633	1.062652
46	1.082525	1.125105	47	1.104900	1.147144
47	1.169092	1.213078	48	1.190806	1.234465
48	1.258688	1.304298	49	1.279751	1.325038
49	1.351792	1.399287	50	1.372213	1.419388
50	1.448985	1.498683	51	1.468769	1.518150
51	1.550979	1.603276	52	1.570131	1.622112
52	1.658672	1.714068	53	1.677192	1.732272
53	1.773212	1.832356	54	1.791098	1.849924
54	1.896112	1.959868	55	1.913358	1.976792
55	2.029429	2.098989	56	2.046023	2.115254
56	2.176068	2.253147	57	2.191992	2.268731
57	2.340352	2.427557	58	2.355579	2.442426
58	2.529159	2.630762	59	2.543647	2.644867
59	2.754568	2.878375	60	2.768249	2.891632
60	3.041348	3.204322	61	3.054108	3.216583
61	3.458118	3.711915	62	3.469710	3.722837
	ERROR =	0.000708		ERROR =	0.000686
	ENTROPY =	5.641821		ENTROPY =	5.664934

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 63		
J	X	Y
32	-0.033939	0.000000
33	0.033938	0.067877
34	0.101868	0.135859
35	0.169954	0.204050
36	0.238305	0.272559
37	0.307029	0.341498
38	0.376240	0.410982
39	0.446058	0.481134
40	0.516609	0.552084
41	0.588029	0.623973
42	0.660464	0.696954
43	0.734074	0.771194
44	0.809036	0.846879
45	0.885548	0.924217
46	0.963830	1.003442
47	1.044134	1.084826
48	1.126752	1.168678
49	1.212021	1.255363
50	1.300338	1.345313
51	1.392179	1.439046
52	1.488120	1.537194
53	1.588869	1.640545
54	1.695318	1.750092
55	1.808609	1.867126
56	1.930247	1.993368
57	2.062279	2.131190
58	2.207598	2.284005
59	2.370505	2.457006
60	2.557853	2.658701
61	2.781670	2.904640
62	3.066629	3.228619
63	3.481091	3.733563
ERROR =		0.000665
ENTROPY =		5.687683

N = 64		
J	X	Y
33	0.000000	0.033409
34	0.066844	0.100278
35	0.133787	0.167297
36	0.200932	0.234567
37	0.268380	0.302193
38	0.336238	0.370283
39	0.404616	0.438950
40	0.473632	0.508314
41	0.543408	0.578503
42	0.614079	0.649655
43	0.685789	0.721922
44	0.758695	0.795468
45	0.832972	0.870476
46	0.908816	0.947155
47	0.986446	1.025736
48	1.066112	1.106482
49	1.148104	1.189720
50	1.232757	1.275791
51	1.320468	1.365141
52	1.411709	1.458276
53	1.507054	1.555831
54	1.607210	1.658589
55	1.713065	1.767542
56	1.825759	1.883977
57	1.946794	2.009611
58	2.078211	2.146810
59	2.222896	2.298981
60	2.385143	2.471305
61	2.571789	2.672274
62	2.794840	2.917407
63	3.078922	3.240437
64	3.492269	3.744101
ERROR =		0.000644
ENTROPY =		5.710079

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 65		
J	X	Y
33	-0.032909	0.000000
34	0.032909	0.065817
35	0.098774	0.131730
36	0.164782	0.197834
37	0.231031	0.264228
38	0.297620	0.331012
39	0.364652	0.398292
40	0.432235	0.466179
41	0.500484	0.534789
42	0.569520	0.604250
43	0.639473	0.674696
44	0.710486	0.746276
45	0.782716	0.819155
46	0.856334	0.893514
47	0.931536	0.969557
48	1.008537	1.047518
49	1.087589	1.127660
50	1.168977	1.210293
51	1.253035	1.295777
52	1.340159	1.384540
53	1.430819	1.477097
54	1.525587	1.574077
55	1.625168	1.676260
56	1.730448	1.784636
57	1.842563	1.900490
58	1.963011	2.025532
59	2.093829	2.162126
60	2.237898	2.313670
61	2.399502	2.485334
62	2.585464	2.685595
63	2.807768	2.929941
64	3.090993	3.252044
65	3.503250	3.754457
ERROR =	0.000625	
ENTROPY =	5.732130	

N = 66		
J	X	Y
34	0.000000	0.032411
35	0.064845	0.097279
36	0.129782	0.162284
37	0.194901	0.227518
38	0.260298	0.293077
39	0.326068	0.359058
40	0.392312	0.425565
41	0.459135	0.492705
42	0.526650	0.560594
43	0.594975	0.629356
44	0.664240	0.699124
45	0.734585	0.770045
46	0.806164	0.842282
47	0.879149	0.916015
48	0.953731	0.991447
49	1.030127	1.068808
50	1.108585	1.148362
51	1.189389	1.230416
52	1.272873	1.315329
53	1.359429	1.403528
54	1.449526	1.495525
55	1.543735	1.591946
56	1.642759	1.693571
57	1.747480	1.801388
58	1.859032	1.916676
59	1.978910	2.041144
60	2.109146	2.177148
61	2.252614	2.328081
62	2.413592	2.499102
63	2.598887	2.698672
64	2.820462	2.942251
65	3.102849	3.263448
66	3.514042	3.764636
ERROR =	0.000606	
ENTROPY =	5.753849	

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 67		
J	X	Y
34	-0.031940	0.000000
35	0.031940	0.063879
36	0.095862	0.127846
37	0.159916	0.191987
38	0.224190	0.256392
39	0.288774	0.321155
40	0.353762	0.386369
41	0.419253	0.452136
42	0.485349	0.518562
43	0.552160	0.585759
44	0.619804	0.653850
45	0.688408	0.722966
46	0.758110	0.793254
47	0.829064	0.864874
48	0.901438	0.938003
49	0.975424	1.012845
50	1.051236	1.089627
51	1.129120	1.168613
52	1.209360	1.250108
53	1.292268	1.334468
54	1.378294	1.422119
55	1.467846	1.513573
56	1.561513	1.609453
57	1.659995	1.710537
58	1.764174	1.817810
59	1.875179	1.932548
60	1.994502	2.056456
61	2.124172	2.191887
62	2.267056	2.342225
63	2.427422	2.512619
64	2.612067	2.711515
65	2.832929	2.954343
66	3.114499	3.274654
67	3.524649	3.774644
ERROR =		0.000589
ENTROPY =		5.775247

N = 68		
J	X	Y
35	0.000000	0.031471
36	0.062963	0.094455
37	0.126009	0.157563
38	0.189223	0.220882
39	0.252690	0.284497
40	0.316498	0.348499
41	0.380740	0.412980
42	0.445509	0.478039
43	0.510909	0.543779
44	0.577046	0.610312
45	0.644036	0.677759
46	0.712004	0.746249
47	0.781088	0.815927
48	0.851439	0.886951
49	0.923225	0.959496
50	0.996635	1.033771
51	1.071883	1.109985
52	1.149213	1.188431
53	1.228907	1.269384
54	1.311296	1.353209
55	1.396770	1.440330
56	1.485794	1.531257
57	1.578934	1.626612
58	1.676891	1.727170
59	1.780542	1.833913
60	1.891015	1.948117
61	2.009799	2.071481
62	2.138917	2.206352
63	2.281231	2.356110
64	2.441001	2.525893
65	2.625011	2.724130
66	2.845178	2.966225
67	3.125948	3.285670
68	3.535079	3.784437
ERROR =		0.000572
ENTROPY =		5.796331

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 69

J	X	Y
35	-0.031026	0.000000
36	0.031026	0.062052
37	0.093118	0.124184
38	0.155330	0.186476
39	0.217743	0.249010
40	0.280440	0.311871
41	0.343508	0.375145
42	0.407034	0.438924
43	0.471114	0.503304
44	0.535845	0.568387
45	0.601334	0.634282
46	0.667696	0.701109
47	0.735053	0.768997
48	0.803542	0.838087
49	0.873312	0.908537
50	0.944530	0.980523
51	1.017384	1.054245
52	1.092086	1.129928
53	1.168880	1.207832
54	1.248046	1.288260
55	1.329914	1.371567
56	1.414871	1.458174
57	1.503382	1.548590
58	1.596012	1.643434
59	1.693458	1.743481
60	1.796596	1.849710
61	1.906552	1.963393
62	2.024810	2.086227
63	2.153390	2.220554
64	2.295149	2.369745
65	2.454338	2.538931
66	2.637728	2.736526
67	2.857215	2.977904
68	3.137203	3.296502
69	3.545336	3.794170

ERROR = 0.000555
ENTROPY = 5.817111

N = 70

J	X	Y
36	0.000000	0.030584
37	0.061187	0.091789
38	0.122450	0.153110
39	0.183867	0.214623
40	0.245516	0.276408
41	0.307478	0.338547
42	0.369836	0.401125
43	0.432678	0.464231
44	0.496095	0.527959
45	0.560185	0.592411
46	0.625052	0.657693
47	0.690809	0.723924
48	0.757577	0.791230
49	0.825492	0.859754
50	0.894702	0.929650
51	0.965372	1.001094
52	1.037689	1.074284
53	1.111864	1.149444
54	1.188138	1.226833
55	1.266793	1.306753
56	1.348155	1.389557
57	1.432611	1.475665
58	1.520625	1.565584
59	1.612758	1.659933
60	1.709708	1.759483
61	1.812347	1.865211
62	1.921799	1.978387
63	2.039546	2.100704
64	2.167602	2.234500
65	2.308819	2.383139
66	2.467440	2.551742
67	2.650225	2.748708
68	2.869047	2.989386
69	3.148270	3.307154
70	3.555426	3.803697

ERROR = 0.000540
ENTROPY = 5.837596

TABLE 1

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 71		
J	X	Y
36	-0.030163	0.000000
37	0.030163	0.060326
38	0.090526	0.120726
39	0.151000	0.181273
40	0.211658	0.242043
41	0.272577	0.303111
42	0.333835	0.364559
43	0.395515	0.426470
44	0.457700	0.488930
45	0.520481	0.552033
46	0.583955	0.615877
47	0.648223	0.680569
48	0.713397	0.746225
49	0.779599	0.812972
50	0.846960	0.880948
51	0.915629	0.950309
52	0.985769	1.021229
53	1.057567	1.093904
54	1.131231	1.168558
55	1.207004	1.245449
56	1.285162	1.324876
57	1.366034	1.407192
58	1.450004	1.492816
59	1.537534	1.582252
60	1.629185	1.676119
61	1.725652	1.775185
62	1.827806	1.880426
63	1.936767	1.993109
64	2.054015	2.114922
65	2.181560	2.248199
66	2.322249	2.396299
67	2.480316	2.564333
68	2.662509	2.760685
69	2.880681	3.000678
70	3.159156	3.317633
71	3.565354	3.813074
ERROR =		0.000525
ENTROPY =		5.857794

N = 72		
J	X	Y
37	0.000000	0.029745
38	0.059508	0.089271
39	0.119086	0.148902
40	0.178806	0.208710
41	0.238739	0.268768
42	0.298960	0.329152
43	0.359544	0.389937
44	0.420573	0.451208
45	0.482128	0.513048
46	0.544298	0.575549
47	0.607179	0.638809
48	0.670871	0.702933
49	0.735484	0.768035
50	0.801138	0.834241
51	0.867965	0.901689
52	0.936111	0.970533
53	1.005740	1.040946
54	1.077034	1.113123
55	1.150205	1.187286
56	1.225490	1.263693
57	1.303168	1.342642
58	1.383564	1.424485
59	1.467061	1.509638
60	1.554121	1.598605
61	1.645304	1.692003
62	1.741301	1.790599
63	1.842982	1.895365
64	1.951465	2.007566
65	2.068227	2.128888
66	2.195274	2.261659
67	2.335446	2.409233
68	2.492972	2.576711
69	2.674586	2.772462
70	2.892123	3.011784
71	3.169865	3.327945
72	3.575124	3.822304
ERROR =		0.000511
ENTROPY =		5.877713

TABLE 1

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 73

J	X	Y
37	-0.029347	0.000000
38	0.029347	0.058694
39	0.088075	0.117456
40	0.146905	0.176353
41	0.205904	0.235455
42	0.265144	0.294833
43	0.324696	0.354559
44	0.384634	0.414710
45	0.445037	0.475365
46	0.505987	0.536609
47	0.567570	0.598531
48	0.629880	0.661229
49	0.693017	0.724805
50	0.757088	[illegible]
51	0.822214	0.855057
52	0.888525	0.921994
53	0.956166	0.990338
54	1.025299	[illegible]
55	1.096107	1.131954
56	[illegible]	1.205642
57	[illegible]	[illegible]
58	[illegible]	1.360065
59	1.400756	[illegible]
60	1.483795	[illegible]
61	1.570398	1.614654
62	1.661125	1.707595
63	1.756664	1.805733
64	1.857885	1.910037
65	1.965902	2.021768
66	2.082190	2.142611
67	2.208750	2.274838
68	2.348418	2.421948
69	2.505415	2.588882
70	2.686464	2.784046
71	2.903379	3.022712
72	3.180402	3.338093
73	3.584743	3.831392

ERROR = 0.000497
ENTROPY = 5.897360

N = 74

J	X	Y
38	0.000000	0.028951
39	0.057919	0.086887
40	0.115903	0.144919
41	0.174017	0.203115
42	0.232328	0.261541
43	0.290904	0.320266
44	0.349814	0.379362
45	0.409133	0.438903
46	0.468935	0.498967
47	0.529302	0.559637
48	0.590320	0.621002
49	0.652080	0.683157
50	0.714681	0.746204
51	0.778230	0.810256
52	0.842846	0.875436
53	0.908658	0.941880
54	0.975810	1.009740
55	1.044463	1.079186
56	1.114799	1.150413
57	1.187026	1.223640
58	1.261381	[illegible]
59	1.338139	1.377156
60	[illegible]	1.458091
61	1.500216	1.542342
62	1.586375	1.630409
63	1.676658	1.722906
64	1.771752	1.820597
65	1.872523	1.924450
66	1.980087	2.035724
67	2.095911	2.156099
68	2.221996	2.287894
69	2.361172	2.434451
70	2.517652	2.600853
71	2.698148	2.795442
72	2.914454	3.033465
73	3.190774	3.348083
74	3.594213	3.840343

ERROR = 0.000484
ENTROPY = 5.916743

TABLE 1

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 75		
J	X	Y
38	-0.028574	0.000000
39	0.028574	0.057148
40	0.085753	0.114359
41	0.143026	0.171694
42	0.200456	0.229219
43	0.258108	0.286997
44	0.316047	0.345096
45	0.374342	0.403587
46	0.433064	0.462541
47	0.492289	0.522037
48	0.552096	0.582155
49	0.612569	0.642982
50	0.673798	0.704614
51	0.735882	0.767151
52	0.798927	0.830704
53	0.863050	0.895396
54	0.928379	0.961362
55	0.995057	1.028753
56	1.063246	1.097739
57	1.133125	1.168511
58	1.204901	1.241291
59	1.278811	1.316331
60	1.355129	1.393928
61	1.434178	1.474427
62	1.516336	1.558245
63	1.602063	1.645880
64	1.691912	1.737945
65	1.786572	1.835200
66	1.886907	1.938613
67	1.994027	2.049440
68	2.109399	2.169358
69	2.235020	2.300682
70	2.373715	2.446748
71	2.529689	2.612631
72	2.709644	2.806657
73	2.925354	3.044050
74	3.200985	3.357920
75	3.603540	3.849160
ERROR =		0.000471
ENTROPY =		5.935869

N = 76		
J	X	Y
39	0.000000	0.028199
40	0.056413	0.084627
41	0.112885	0.141144
42	0.169479	0.197813
43	0.226253	0.254694
44	0.283272	0.311851
45	0.340600	0.369350
46	0.398304	0.427258
47	0.456454	0.485649
48	0.515123	0.544597
49	0.574389	0.604182
50	0.634337	0.664491
51	0.695054	0.725617
52	0.756639	0.787661
53	0.819197	0.850732
54	0.882842	0.914952
55	0.947704	0.980455
56	1.013924	1.047392
57	1.081662	1.115931
58	1.151097	1.186264
59	1.222436	1.258609
60	1.295914	1.333219
61	1.371804	1.410390
62	1.450428	1.490466
63	1.532165	1.573863
64	1.617470	1.661077
65	1.706898	1.752720
66	1.801135	1.849550
67	1.901042	1.952534
68	2.007730	2.062925
69	2.122661	2.182397
70	2.247829	2.313261
71	2.386053	2.458846
72	2.541533	2.624220
73	2.720957	2.817695
74	2.936083	3.054471
75	3.211039	3.367607
76	3.612727	3.857846
ERROR =		0.000459
ENTROPY =		5.954745

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 77		
J	X	Y
39	-0.027841	0.000000
40	0.027841	0.055681
41	0.083551	0.111420
42	0.139348	0.167275
43	0.195290	0.223305
44	0.251437	0.279568
45	0.307849	0.336129
46	0.364590	0.393050
47	0.421725	0.450400
48	0.479323	0.508247
49	0.537457	0.566667
50	0.596203	0.625739
51	0.655643	0.685548
52	0.715866	0.746185
53	0.776969	0.807752
54	0.839054	0.870357
55	0.902238	0.934120
56	0.966647	0.999175
57	1.032423	1.065671
58	1.099723	1.133776
59	1.168728	1.203681
60	1.239643	1.275604
61	1.312700	1.349797
62	1.388175	1.426553
63	1.466386	1.506218
64	1.547711	1.589204
65	1.632606	1.676008
66	1.721624	1.767239
67	1.815448	1.863656
68	1.914939	1.966221
69	2.021204	2.076186
70	2.135704	2.195222
71	2.260429	2.325635
72	2.398193	2.470750
73	2.553188	2.635626
74	2.732094	2.828562
75	2.946648	3.064734
76	3.220942	3.377150
77	3.621778	3.866407
ERROR =		0.000447
ENTROPY =		5.973376

N = 78		
J	X	Y
40	0.000000	0.027484
41	0.054983	0.082481
42	0.110021	0.137561
43	0.165171	0.192781
44	0.220489	0.248197
45	0.276033	0.303869
46	0.331862	0.359856
47	0.388039	0.416222
48	0.444627	0.473032
49	0.501694	0.530356
50	0.559311	0.588267
51	0.617555	0.646843
52	0.676506	0.706168
53	0.736251	0.766334
54	0.796887	0.827439
55	0.858516	0.889592
56	0.921252	0.952912
57	0.985222	1.017533
58	1.050567	1.083601
59	1.117443	1.151286
60	1.186030	1.220775
61	1.256532	1.292288
62	1.329181	1.366075
63	1.404251	1.442428
64	1.482060	1.521692
65	1.562985	1.604278
66	1.647480	1.690682
67	1.736097	1.781512
68	1.829518	1.877524
69	1.928603	1.979681
70	2.034455	2.089230
71	2.148535	2.207839
72	2.272826	2.337812
73	2.410140	2.482467
74	2.564661	2.646855
75	2.743059	2.839262
76	2.957052	3.074841
77	3.230696	3.386552
78	3.630698	3.874844
ERROR =		0.000436
ENTROPY =		5.991770

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 79

J	X	Y
40	-0.027144	0.000000
41	0.027144	0.054288
42	0.081459	0.108630
43	0.135854	0.163078
44	0.190384	0.217689
45	0.245103	0.272517
46	0.300068	0.327619
47	0.355337	0.383055
48	0.410970	0.438886
49	0.467031	0.495177
50	0.523586	0.551996
51	0.580705	0.609415
52	0.638463	0.667512
53	0.696941	0.726370
54	0.756225	0.786079
55	0.816408	0.846738
56	0.877595	0.908453
57	0.939898	0.971344
58	1.003443	1.035542
59	1.068369	1.101196
60	1.134834	1.168471
61	1.203014	1.237558
62	1.273114	1.308671
63	1.345367	1.382062
64	1.420042	1.458023
65	1.497459	1.536896
66	1.577994	1.619093
67	1.662100	1.705107
68	1.750326	1.795545
69	1.843354	1.891163
70	1.942042	1.992920
71	2.047491	2.102062
72	2.161159	2.220255
73	2.285026	2.349797
74	2.421900	2.494002
75	2.575957	2.657912
76	2.753857	2.849801
77	2.967300	3.084799
78	3.240308	3.395816
79	3.639489	3.883161

ERROR = 0.000425
ENTROPY = 6.009932

N = 80

J	X	Y
41	0.000000	0.026805
42	0.053624	0.080442
43	0.107299	0.134156
44	0.161078	0.187999
45	0.215012	0.242025
46	0.269156	0.296287
47	0.323564	0.350842
48	0.378294	0.405746
49	0.433404	0.461062
50	0.488957	0.516852
51	0.545018	0.573184
52	0.601656	0.630128
53	0.658946	0.687763
54	0.716966	0.746168
55	0.775802	0.805436
56	0.835548	0.865661
57	0.896307	0.926952
58	0.958189	0.989426
59	1.021321	1.053215
60	1.085841	1.118466
61	1.151905	1.185344
62	1.219691	1.254038
63	1.289400	1.324763
64	1.361266	1.397769
65	1.435558	1.473347
66	1.512594	1.551840
67	1.592748	1.633657
68	1.676473	1.719290
69	1.764318	1.809347
70	1.856963	1.904579
71	1.955262	2.005946
72	2.060318	2.114690
73	2.173583	2.232475
74	2.297036	2.361596
75	2.433478	2.505360
76	2.587081	2.668802
77	2.764492	2.860183
78	2.977397	3.094610
79	3.249779	3.404948
80	3.648155	3.891362

ERROR = 0.000415
ENTROPY = 6.027868

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 81

J	X	Y
41	-0.026482	0.000000
42	0.026481	0.052963
43	0.079469	0.105975
44	0.132531	0.159087
45	0.185718	0.212349
46	0.239081	0.265813
47	0.292672	0.319531
48	0.346545	0.373559
49	0.400755	0.427952
50	0.455361	0.482771
51	0.510424	0.538077
52	0.566008	0.593938
53	0.622181	0.650424
54	0.679017	0.707610
55	0.736594	0.765578
56	0.794998	0.824417
57	0.854320	0.884223
58	0.914663	0.945102
59	0.976137	1.007172
60	1.038868	1.070564
61	1.102993	1.135423
62	1.168669	1.201914
63	1.236070	1.270226
64	1.305400	1.340574
65	1.376889	1.413205
66	1.450808	1.488410
67	1.527471	1.566532
68	1.607255	1.647977
69	1.690609	1.733240
70	1.778081	1.822923
71	1.870351	1.917779
72	1.968271	2.018764
73	2.072942	2.127120
74	2.185813	2.244506
75	2.308860	2.373214
76	2.444880	2.516546
77	2.598037	2.679529
78	2.774970	2.870412
79	2.987346	3.104280
80	3.259115	3.413950
81	3.656700	3.899450

ERROR = 0.000405
ENTROPY = 6.045584

N = 82

J	X	Y
42	0.000000	0.026159
43	0.052330	0.078501
44	0.104708	0.130915
45	0.157182	0.183450
46	0.209801	0.236153
47	0.262615	0.289076
48	0.315673	0.342271
49	0.369030	0.395790
50	0.422740	0.449690
51	0.476859	0.504029
52	0.531449	0.558869
53	0.586572	0.614275
54	0.642296	0.670316
55	0.698693	0.727069
56	0.755841	0.784613
57	0.813825	0.843037
58	0.872736	0.902436
59	0.932676	0.962916
60	0.993754	1.024593
61	1.056096	1.087598
62	1.119837	1.152076
63	1.185134	1.218192
64	1.252162	1.286132
65	1.321122	1.356111
66	1.392244	1.428377
67	1.465798	1.503219
68	1.542099	1.580979
69	1.621521	1.662063
70	1.704513	1.746963
71	1.791622	1.836281
72	1.883525	1.930769
73	1.981075	2.031381
74	2.085369	2.139356
75	2.197854	2.256352
76	2.320504	2.384656
77	2.456110	2.527564
78	2.608831	2.690098
79	2.785295	2.880492
80	2.997152	3.113811
81	3.268318	3.422826
82	3.665126	3.907427

ERROR = 0.000395
ENTROPY = 6.063084

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 83		
J	X	Y
42	-0.025851	0.000000
43	0.025850	0.051701
44	0.077574	0.103448
45	0.129368	0.155287
46	0.181277	0.207266
47	0.233350	0.259433
48	0.285634	0.311836
49	0.338181	0.364525
50	0.391040	0.417555
51	0.444267	0.470979
52	0.497917	0.524854
53	0.552049	0.579243
54	0.606726	0.634209
55	0.662015	0.689821
56	0.717987	0.746153
57	0.774720	0.803287
58	0.832297	0.861308
59	0.890810	0.920312
60	0.950358	0.980404
61	1.011052	1.041700
62	1.073014	1.104329
63	1.136383	1.168437
64	1.201311	1.234186
65	1.267976	1.301765
66	1.336575	1.371385
67	1.407340	1.443295
68	1.480539	1.517783
69	1.556486	1.595189
70	1.635554	1.675920
71	1.718192	1.760465
72	1.804946	1.849427
73	1.896492	1.943556
74	1.993679	2.043802
75	2.097604	2.151406
76	2.209712	2.268019
77	2.331973	2.395926
78	2.467173	2.538420
79	2.619467	2.700513
80	2.795471	2.890428
81	3.006818	3.123208
82	3.277393	3.431578
83	3.673438	3.915297
ERROR =	0.000386	
ENTROPY =	6.080375	

N = 84		
J	X	Y
43	0.000000	0.025543
44	0.051098	0.076652
45	0.102240	0.127828
46	0.153472	0.179115
47	0.204838	0.230560
48	0.256385	0.282210
49	0.308161	0.334111
50	0.360213	0.386315
51	0.412593	0.438871
52	0.465353	0.491835
53	0.518549	0.545263
54	0.572239	0.599215
55	0.626485	0.653755
56	0.681353	0.708951
57	0.736914	0.764876
58	0.793244	0.821611
59	0.850426	0.879241
60	0.908551	0.937862
61	0.967719	0.997577
62	1.028039	1.058502
63	1.089634	1.120766
64	1.152640	1.184513
65	1.217210	1.249907
66	1.283519	1.317132
67	1.351768	1.386403
68	1.422184	1.457966
69	1.495037	1.532108
70	1.570638	1.609169
71	1.649362	1.689555
72	1.731654	1.773754
73	1.818061	1.862368
74	1.909256	1.956145
75	2.006089	2.056034
76	2.109653	2.163273
77	2.221392	2.279[illegible]
78	2.343271	2.407[illegible]
79	2.478075	2.549[illegible]
80	2.629948	2.710778
81	2.805501	2.900224
82	3.016349	3.132474
83	3.286343	3.440212
84	3.681637	3.923061
ERROR =	0.000377	
ENTROPY =	6.097461	

TABLE 1

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 85

J	X	Y
43	-0.025249	0.000000
44	0.025249	0.050498
45	0.075768	0.101038
46	0.126352	0.151665
47	0.177043	0.202422
48	0.227887	0.253353
49	0.278928	0.304504
50	0.330213	0.355922
51	0.381789	0.407656
52	0.433706	0.459756
53	0.486016	0.512276
54	0.538773	0.565270
55	0.592035	0.618800
56	0.645864	0.672927
57	0.700323	0.727720
58	0.755485	0.783250
59	0.811424	0.839598
60	0.868224	0.896849
61	0.925973	0.955097
62	0.984771	1.014446
63	1.044728	1.075010
64	1.105964	1.136919
65	1.168617	1.200315
66	1.232838	1.265361
67	1.298802	1.332243
68	1.366708	1.401173
69	1.436785	1.472397
70	1.509299	1.546201
71	1.584564	1.622926
72	1.662950	1.702974
73	1.744905	1.786836
74	1.830972	1.875109
75	1.921825	1.968541
76	2.018311	2.068081
77	2.121522	2.174963
78	2.232899	2.290835
79	2.354405	2.417974
80	2.488818	2.559663
81	2.640281	2.720898
82	2.815390	2.909882
83	3.025747	3.141613
84	3.295171	3.448728
85	3.689725	3.930724

ERROR = 0.000368
ENTROPY = 6.114346

N = 86

J	X	Y
44	0.000000	0.024956
45	0.049922	0.074888
46	0.099885	0.124883
47	0.149932	0.174982
48	0.200104	0.225227
49	0.250445	0.275663
50	0.300999	0.326334
51	0.351810	0.377286
52	0.402926	0.428566
53	0.454396	0.480225
54	0.506270	0.532315
55	0.558603	0.584891
56	0.611451	0.638011
57	0.664875	0.691738
58	0.718939	0.746140
59	0.773714	0.801287
60	0.829274	0.857260
61	0.885701	0.914142
62	0.943085	0.972028
63	1.001524	1.031020
64	1.061127	1.091234
65	1.122015	1.152796
66	1.184323	1.215850
67	1.248204	1.280558
68	1.313832	1.347105
69	1.381404	1.415703
70	1.451149	1.486596
71	1.523333	1.560071
72	1.598268	1.636466
73	1.676326	1.716185
74	1.757951	1.799716
75	1.843686	1.887656
76	1.934204	1.980751
77	2.030350	2.079949
78	2.133215	2.186481
79	2.244237	2.301993
80	2.365377	2.428760
81	2.499409	2.570057
82	2.650467	2.730877
83	2.825142	2.919407
84	3.035017	3.150627
85	3.303879	3.457131
86	3.697709	3.938287

ERROR = 0.000359
ENTROPY = 6.131036

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 87		
J	X	Y
44	-0.024675	0.000000
45	0.024674	0.049349
46	0.074044	0.098738
47	0.123473	0.148208
48	0.173003	0.197799
49	0.222675	0.247552
50	0.272531	0.297511
51	0.322615	0.347718
52	0.372969	0.398220
53	0.423641	0.449062
54	0.474678	0.500294
55	0.526131	0.551968
56	0.578053	0.604138
57	0.630499	0.656861
58	0.683531	0.710201
59	0.737212	0.764223
60	0.791611	0.818999
61	0.846803	0.874606
62	0.902868	0.931130
63	0.959897	0.988664
64	1.017987	1.047310
65	1.077246	1.107182
66	1.137794	1.168406
67	1.199767	1.231127
68	1.263317	1.295506
69	1.328616	1.361726
70	1.395862	1.429999
71	1.465284	1.500569
72	1.537145	1.573722
73	1.611759	1.649796
74	1.689494	1.729193
75	1.770797	1.812400
76	1.856207	1.900014
77	1.946397	1.992780
78	2.042211	2.091642
79	2.144737	2.197832
80	2.255412	2.312992
81	2.376192	2.439392
82	2.509849	2.580306
83	2.660511	2.740717
84	2.834759	2.928802
85	3.044161	3.159520
86	3.312472	3.465423
87	3.705588	3.945753
ERROR =		0.000351
ENTROPY =		6.147535

N = 88		
J	X	Y
45	0.000000	0.024395
46	0.048799	0.073203
47	0.097637	0.122070
48	0.146552	0.171035
49	0.195585	0.220136
50	0.244775	0.269415
51	0.294164	0.318913
52	0.343793	0.368673
53	0.393706	0.418739
54	0.443948	0.469158
55	0.494567	0.519977
56	0.545612	0.571248
57	0.597136	0.623024
58	0.649194	0.675364
59	0.701845	0.728327
60	0.755154	0.781980
61	0.809188	0.836395
62	0.864022	0.891648
63	0.919736	0.947824
64	0.976419	1.005015
65	1.034169	1.063323
66	1.093093	1.122862
67	1.153310	1.183758
68	1.214956	1.246155
69	1.278183	1.310211
70	1.343162	1.376112
71	1.410090	1.444068
72	1.479196	1.514323
73	1.550742	1.587162
74	1.625042	1.662921
75	1.702462	1.742003
76	1.783449	1.824894
77	1.868542	1.912189
78	1.958410	2.004631
79	2.053898	2.103166
80	2.156092	2.209019
81	2.266427	2.323834
82	2.386855	2.449876
83	2.520145	2.590413
84	2.670418	2.750422
85	2.844246	2.938070
86	3.053183	3.168295
87	3.320951	3.473608
88	3.713365	3.953123
ERROR =		0.000344
ENTROPY =		6.163848

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 89		
J	X	Y
45	-0.024126	0.000000
46	0.024126	0.048252
47	0.072396	0.096541
48	0.120723	0.144905
49	0.169144	0.193383
50	0.217697	0.242012
51	0.266423	0.290833
52	0.315360	0.339887
53	0.364550	0.389214
54	0.414037	0.438859
55	0.463863	0.488868
56	0.514077	0.539287
57	0.564727	0.590168
58	0.615865	0.641563
59	0.667546	0.693529
60	0.719828	0.746127
61	0.772775	0.799423
62	0.826455	0.853487
63	0.880941	0.908395
64	0.936313	0.964232
65	0.992660	1.021089
66	1.050079	1.079069
67	1.108676	1.138283
68	1.168572	1.198860
69	1.229899	1.260939
70	1.292810	1.324682
71	1.357477	1.390271
72	1.424095	1.457918
73	1.492891	1.527864
74	1.564130	1.600396
75	1.638122	1.675848
76	1.715235	1.754622
77	1.795912	1.837203
78	1.880694	1.924185
79	1.970248	2.016311
80	2.065418	2.114524
81	2.167286	2.220048
82	2.277286	2.334524
83	2.397369	2.460214
84	2.530298	2.600382
85	2.680189	2.759997
86	2.853606	2.947215
87	3.062085	3.176955
88	3.329321	3.481686
89	3.721044	3.960401
ERROR =		0.000336
ENTROPY =		6.179978

N = 90		
J	X	Y
46	0.000000	0.023858
47	0.047725	0.071593
48	0.095487	0.119382
49	0.143322	0.167262
50	0.191266	0.215270
51	0.239358	0.263445
52	0.287634	0.311824
53	0.336135	0.360447
54	0.384902	0.409357
55	0.433976	0.458595
56	0.483400	0.508206
57	0.533222	0.558238
58	0.583489	0.608740
59	0.634253	0.659765
60	0.685567	0.711369
61	0.737491	0.763613
62	0.790087	0.816561
63	0.843422	0.870283
64	0.897570	0.924856
65	0.952610	0.980363
66	1.008629	1.036896
67	1.065725	1.094555
68	1.124004	1.153454
69	1.183586	1.213717
70	1.244603	1.275488
71	1.307206	1.338924
72	1.371567	1.404210
73	1.437882	1.471554
74	1.506377	1.541199
75	1.577315	1.613430
76	1.651006	1.688582
77	1.727818	1.767054
78	1.808193	1.849332
79	1.892670	1.936008
80	1.981916	2.027824
81	2.076772	2.125721
82	2.178322	2.230923
83	2.287995	2.345066
84	2.407738	2.470411
85	2.540313	2.610215
86	2.689829	2.769443
87	2.862841	2.956239
88	3.070871	3.185503
89	3.337583	3.489662
90	3.728626	3.967589
ERROR =		0.000329
ENTROPY =		6.195929

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 91		
J	X	Y
46	-0.023601	0.000000
47	0.023601	0.047202
48	0.070820	0.094439
49	0.118093	0.141746
50	0.165453	0.189160
51	0.212938	0.236715
52	0.260583	0.284450
53	0.308426	0.332402
54	0.356506	0.380610
55	0.404862	0.429115
56	0.453537	0.477958
57	0.502572	0.527185
58	0.552013	0.576841
59	0.601909	0.626976
60	0.652309	0.677642
61	0.703269	0.728895
62	0.754845	0.780794
63	0.807099	0.833404
64	0.860099	0.886794
65	0.913917	0.941041
66	0.968634	0.996226
67	1.024334	1.052442
68	1.081116	1.109790
69	1.139085	1.168380
70	1.198360	1.228339
71	1.259073	1.289808
72	1.321376	1.352945
73	1.385439	1.417934
74	1.451458	1.484982
75	1.519658	1.554333
76	1.590302	1.626270
77	1.663699	1.701127
78	1.740216	1.779305
79	1.820295	1.861285
80	1.904473	1.947662
81	1.993418	2.039174
82	2.087968	2.136762
83	2.189204	2.241647
84	2.298555	2.355464
85	2.417967	2.480469
86	2.550194	2.619918
87	2.699341	2.778765
88	2.871955	2.965146
89	3.079543	3.193941
90	3.345739	3.497537
91	3.736113	3.974689
	ERROR =	0.000321
	ENTROPY =	6.211706

N = 92		
J	X	Y
47	0.000000	0.023345
48	0.046698	0.070052
49	0.093431	0.116810
50	0.140231	0.163653
51	0.187134	0.210616
52	0.234175	0.257734
53	0.281389	0.305044
54	0.328814	0.352583
55	0.376486	0.400389
56	0.424446	0.448502
57	0.472733	0.496964
58	0.521390	0.545817
59	0.570463	0.595109
60	0.619999	0.644888
61	0.670047	0.695205
62	0.720661	0.746116
63	0.771898	0.797680
64	0.823821	0.849961
65	0.876495	0.903028
66	0.929993	0.956957
67	0.984393	1.011830
68	1.039784	1.067737
69	1.096259	1.124780
70	1.153925	1.183070
71	1.212901	1.242732
72	1.273319	1.303906
73	1.335328	1.366751
74	1.399100	1.431449
75	1.464829	1.498209
76	1.532740	1.567272
77	1.603096	1.638921
78	1.676206	1.713490
79	1.752434	1.791378
80	1.832223	1.873068
81	1.916109	1.959151
82	2.004758	2.050365
83	2.099007	2.147649
84	2.199937	2.252224
85	2.308973	2.365721
86	2.428057	2.490394
87	2.559943	2.629492
88	2.708729	2.787965
89	2.880952	2.973938
90	3.088105	3.202272
91	3.353794	3.505315
92	3.743508	3.981702
	ERROR =	0.000315
	ENTROPY =	6.227312

TABLE 1

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 93		
J	X	Y
47	-0.023099	0.000000
48	0.023098	0.046197
49	0.069312	0.092427
50	0.115575	0.138723
51	0.161920	0.185118
52	0.208382	0.231646
53	0.254995	0.278343
54	0.301792	0.325242
55	0.348812	0.372381
56	0.396090	0.419798
57	0.443665	0.467531
58	0.491577	0.515622
59	0.539868	0.564114
60	0.588584	0.613053
61	0.637769	0.662486
62	0.687475	0.712464
63	0.737753	0.763043
64	0.788662	0.814281
65	0.840261	0.866242
66	0.892618	0.919994
67	0.945804	0.972613
68	0.999897	1.027181
69	1.054984	1.082788
70	1.111161	1.139534
71	1.168532	1.197530
72	1.227216	1.256902
73	1.287345	1.317788
74	1.349067	1.380347
75	1.412554	1.444762
76	1.478000	1.511239
77	1.545630	1.580020
78	1.615704	1.651388
79	1.688532	1.725675
80	1.764478	1.803280
81	1.843983	1.884685
82	1.927582	1.970480
83	2.015941	2.061402
84	2.109895	2.158389
85	2.210524	2.262659
86	2.319250	2.375841
87	2.438014	2.500187
88	2.569564	2.638941
89	2.717994	2.797047
90	2.889833	2.982618
91	3.096559	3.210499
92	3.361748	3.512997
93	3.750814	3.988631
ERROR =		0.000308
ENTROPY =		6.242751

N = 94		
J	X	Y
48	0.000000	0.022853
49	0.045714	0.068576
50	0.091461	0.114346
51	0.137271	0.160196
52	0.183177	0.206159
53	0.229213	0.252267
54	0.275411	0.298555
55	0.321806	0.345057
56	0.368433	0.391810
57	0.415329	0.438849
58	0.462532	0.486215
59	0.510080	0.533946
60	0.558017	0.582087
61	0.606385	0.630682
62	0.655231	0.679779
63	0.704603	0.729428
64	0.754556	0.779684
65	0.805144	0.830605
66	0.856429	0.882254
67	0.908477	0.934700
68	0.961358	0.988017
69	1.015152	1.042287
70	1.069944	1.097601
71	1.125829	1.154057
72	1.182912	1.211767
73	1.241311	1.270855
74	1.301157	1.331460
75	1.362600	1.393740
76	1.425809	1.457877
77	1.490978	1.524078
78	1.558331	1.592584
79	1.628130	1.663676
80	1.700681	1.737687
81	1.776351	1.815015
82	1.855577	1.896140
83	1.938896	1.981652
84	2.026970	2.072288
85	2.120635	2.168983
86	2.220968	2.272954
87	2.329391	2.385827
88	2.447840	2.509852
89	2.579060	2.648268
90	2.727140	2.806013
91	2.898601	2.991189
92	3.104907	3.218624
93	3.369604	3.520585
94	3.758031	3.995478
ERROR =		0.000301
ENTROPY =		6.258027

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 95		
J	X	Y
48	-0.022617	0.000000
49	0.022617	0.045234
50	0.067866	0.090499
51	0.113162	0.135826
52	0.158536	0.181246
53	0.204018	0.226791
54	0.249642	0.272493
55	0.295439	0.318386
56	0.341445	0.364503
57	0.387692	0.410881
58	0.434218	0.457555
59	0.481059	0.504563
60	0.528255	0.551947
61	0.575847	0.599747
62	0.623877	0.648008
63	0.672393	0.696778
64	0.721442	0.746106
65	0.771077	0.796048
66	0.821354	0.846660
67	0.872333	0.898005
68	0.924079	0.950153
69	0.976664	1.003176
70	1.030166	1.057156
71	1.084670	1.112184
72	1.140270	1.168357
73	1.197072	1.225787
74	1.255193	1.284598
75	1.314763	1.344928
76	1.375932	1.406936
77	1.438868	1.470801
78	1.503766	1.536732
79	1.570850	1.604967
80	1.640378	1.675790
81	1.712660	1.749530
82	1.788058	1.826586
83	1.867012	1.907437
84	1.950055	1.992673
85	2.037850	2.083027
86	2.131232	2.179436
87	2.231274	2.283113
88	2.339398	2.395633
89	2.457538	2.519392
90	2.588434	2.657476
91	2.736171	2.814865
92	2.907260	2.999654
93	3.113152	3.226649
94	3.377365	3.528081
95	3.765163	4.002244
	ERROR =	0.000295
	ENTROPY =	6.273142

N = 96		
J	X	Y
49	0.000000	0.022382
50	0.044771	0.067160
51	0.089572	0.111984
52	0.134433	0.156883
53	0.179385	0.201887
54	0.224457	0.247028
55	0.269683	0.292338
56	0.315093	0.337848
57	0.360721	0.383593
58	0.406600	0.429607
59	0.452767	0.475927
60	0.499258	0.522589
61	0.546111	0.569634
62	0.593368	0.617102
63	0.641071	0.665039
64	0.689265	0.713491
65	0.738000	0.762508
66	0.787326	0.812143
67	0.837299	0.862455
68	0.887980	0.913505
69	0.939433	0.965361
70	0.991729	1.018097
71	1.044946	1.071795
72	1.099169	1.126542
73	1.154491	1.182440
74	1.211018	1.239597
75	1.268867	1.298136
76	1.328167	1.358198
77	1.389068	1.419939
78	1.451739	1.483538
79	1.516371	1.549204
80	1.583190	1.617176
81	1.652455	1.687733
82	1.724471	1.761209
83	1.799604	1.837999
84	1.878290	1.918581
85	1.961063	2.003545
86	2.048584	2.093624
87	2.141687	2.189751
88	2.241445	2.293139
89	2.349276	2.405412
90	2.467111	2.528810
91	2.597689	2.666568
92	2.745088	2.823608
93	2.915811	3.008014
94	3.121296	3.234577
95	3.385033	3.535489
96	3.772210	4.008932
	ERROR =	0.000289
	ENTROPY =	6.288101

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 97

J	X	Y
49	-0.022155	0.000000
50	0.022155	0.044310
51	0.066480	0.088650
52	0.110848	0.133047
53	0.155290	0.177532
54	0.199833	0.222135
55	0.244510	0.266885
56	0.289350	0.311814
57	0.334384	0.356954
58	0.379646	0.402338
59	0.425169	0.448000
60	0.470988	0.493975
61	0.517138	0.540301
62	0.563659	0.587017
63	0.610591	0.634164
64	0.657975	0.681786
65	0.705857	0.729928
66	0.754285	0.778642
67	0.803310	0.827979
68	0.852988	0.877997
69	0.903378	0.929759
70	0.954545	0.980331
71	1.006559	1.032787
72	1.059498	1.086209
73	1.113446	1.140684
74	1.168497	1.196311
75	1.224756	1.253201
76	1.282338	1.311476
77	1.341375	1.371275
78	1.402014	1.432754
79	1.464424	1.496094
80	1.528797	1.561501
81	1.595357	1.629213
82	1.664363	1.699512
83	1.736120	1.772727
84	1.810992	1.849256
85	1.889415	1.929575
86	1.971923	2.014272
87	2.059176	2.104080
88	2.152006	2.199831
89	2.251484	2.303036
90	2.359026	2.415016
91	2.476563	2.538110
92	2.606828	2.675546
93	2.753894	2.832242
94	2.924258	3.016273
95	3.129341	3.242410
96	3.392610	3.542809
97	3.779176	4.015542

ERROR = 0.000283
ENTROPY = 6.302906

N = 98

J	X	Y
50	0.000000	0.021929
51	0.043866	0.065802
52	0.087760	0.109718
53	0.131711	0.153704
54	0.175746	0.197789
55	0.219896	0.242003
56	0.264189	0.286375
57	0.308655	0.330936
58	0.353326	0.375717
59	0.398234	0.420750
60	0.443410	0.466070
61	0.488891	0.511711
62	0.534711	0.557711
63	0.580909	0.604107
64	0.627524	0.650941
65	0.674598	0.698256
66	0.722176	0.746097
67	0.770306	0.794515
68	0.819038	0.843562
69	0.868428	0.893294
70	0.918535	0.943775
71	0.969422	0.995070
72	1.021162	1.047253
73	1.073829	1.100405
74	1.127509	1.154613
75	1.182295	1.209977
76	1.238291	1.266606
77	1.295614	1.324622
78	1.354393	1.384163
79	1.414775	1.445387
80	1.476930	1.508473
81	1.541049	1.573625
82	1.607355	1.641084
83	1.676107	1.711129
84	1.747610	1.784090
85	1.822226	1.860362
86	1.900392	1.940422
87	1.982640	2.024858
88	2.069629	2.114400
89	2.162190	2.209980
90	2.261393	2.312807
91	2.368653	2.424499
92	2.485896	2.547293
93	2.615853	2.684413
94	2.762592	2.840772
95	2.932602	3.024432
96	3.137291	3.250150
97	3.400097	3.550044
98	3.786061	4.022078

ERROR = 0.000278
ENTROPY = 6.317560

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 99		
J	X	Y
50	-0.021712	0.000000
51	0.021712	0.043423
52	0.065149	0.086874
53	0.108627	0.130380
54	0.152174	0.173968
55	0.195817	0.217667
56	0.239585	0.261504
57	0.283507	0.305510
58	0.327612	0.349714
59	0.371930	0.394147
60	0.416493	0.438840
61	0.461334	0.483828
62	0.506487	0.529145
63	0.551986	0.574827
64	0.597870	0.620912
65	0.644177	0.667441
66	0.690949	0.714457
67	0.738232	0.762006
68	0.786071	0.810136
69	0.834517	0.858899
70	0.883626	0.908354
71	0.933457	0.958560
72	0.984072	1.009584
73	1.035543	1.061501
74	1.087945	1.114389
75	1.141363	1.168337
76	1.195890	1.223443
77	1.251630	1.279816
78	1.308698	1.337579
79	1.367224	1.396869
80	1.427356	1.457843
81	1.489261	1.520679
82	1.553131	1.585583
83	1.619188	1.652793
84	1.687691	1.722589
85	1.758945	1.795300
86	1.833310	1.871321
87	1.911224	1.951128
88	1.993217	2.035306
89	2.079947	2.124588
90	2.172244	2.219901
91	2.271178	2.322454
92	2.378159	2.433864
93	2.495113	2.556363
94	2.624768	2.693172
95	2.771185	2.849198
96	2.940846	3.032494
97	3.145146	3.257799
98	3.407497	3.557195
99	3.792867	4.028540
	ERROR =	0.000272
	ENTROPY =	6.332067

N = 100		
J	X	Y
51	0.000000	0.021495
52	0.042997	0.064498
53	0.086020	0.107541
54	0.129096	0.150651
55	0.172253	0.193854
56	0.215516	0.237179
57	0.258915	0.280652
58	0.302477	0.324302
59	0.346231	0.368160
60	0.390207	0.412255
61	0.434437	0.456619
62	0.478951	0.501284
63	0.523785	0.546285
64	0.568972	0.591659
65	0.614550	0.637442
66	0.660558	0.683674
67	0.707037	0.730399
68	0.754031	0.777662
69	0.801587	0.825511
70	0.849755	0.873999
71	0.898590	0.923181
72	0.948150	0.973120
73	0.998500	1.023880
74	1.049708	1.075536
75	1.101852	1.128167
76	1.155014	1.181860
77	1.209287	1.236715
78	1.264776	1.292838
79	1.321595	1.350353
80	1.379875	1.409397
81	1.439761	1.470125
82	1.501421	1.532717
83	1.565047	1.597378
84	1.630861	1.664344
85	1.699120	1.733896
86	1.770129	1.806362
87	1.844249	1.882136
88	1.921915	1.961694
89	2.003657	2.045620
90	2.090133	2.134645
91	2.182171	2.229697
92	2.280839	2.331981
93	2.387547	2.443113
94	2.504217	2.565322
95	2.633574	2.701825
96	2.779674	2.857523
97	2.948992	3.040461
98	3.152910	3.265359
99	3.414812	3.564265
100	3.799597	4.034929
	ERROR =	0.000267
	ENTROPY =	6.346430

TABLE 1

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 101

J	X	Y
51	-0.021286	0.000000
52	0.021286	0.042572
53	0.063870	0.085169
54	0.106494	0.127818
55	0.149181	0.170545
56	0.191960	0.213375
57	0.234856	0.256337
58	0.277897	0.299457
59	0.321110	0.342763
60	0.364524	0.386285
61	0.408168	0.430052
62	0.452073	0.474095
63	0.496271	0.518447
64	0.540794	0.563142
65	0.585678	0.608215
66	0.630959	0.653703
67	0.676675	0.699647
68	0.722868	0.746089
69	0.769581	0.793073
70	0.816861	0.840649
71	0.864758	0.888867
72	0.913326	0.937784
73	0.962623	0.987461
74	1.012713	1.037964
75	1.063655	1.089365
76	1.115555	1.141744
77	1.168467	1.195189
78	1.222493	1.249797
79	1.277736	1.305676
80	1.334312	1.362948
81	1.392349	1.421750
82	1.451995	1.482239
83	1.513416	1.544592
84	1.576803	1.609013
85	1.642377	1.675741
86	1.710397	1.745053
87	1.781166	1.817279
88	1.855045	1.892810
89	1.932467	1.972124
90	2.013963	2.055803
91	2.100189	2.144576
92	2.191973	2.239370
93	2.290380	2.341390
94	2.396819	2.452248
95	2.513210	2.574172
96	2.642274	2.710375
97	2.788063	2.865750
98	2.957042	3.048334
99	3.160583	3.272832
100	3.422043	3.571254
101	3.806251	4.041248

ERROR = 0.000262
ENTROPY = 6.360651

N = 102

J	X	Y
52	0.000000	0.021077
53	0.042161	0.063245
54	0.084347	0.105450
55	0.126584	0.147718
56	0.168896	0.190074
57	0.211309	0.232544
58	0.253849	0.275154
59	0.296542	0.317931
60	0.339417	0.360903
61	0.382501	0.404099
62	0.425823	0.447547
63	0.469413	0.491279
64	0.513303	0.535326
65	0.557524	0.579723
66	0.602113	0.624503
67	0.647104	0.669705
68	0.692536	0.715363
69	0.738451	0.761533
70	0.784890	0.808246
71	0.831900	0.855555
72	0.879532	0.903510
73	0.927839	0.952169
74	0.976879	1.001590
75	1.026716	1.051841
76	1.077418	1.102994
77	1.129060	1.1551[illegible]
78	1.181727	1.208328
79	1.235511	1.262694
80	1.290514	1.318334
81	1.346851	1.375369
82	1.404652	1.433935
83	1.464062	1.494189
84	1.525248	1.556307
85	1.588400	1.620494
86	1.653741	1.686988
87	1.721526	1.756065
88	1.792050	1.828054
89	1.865701	1.903348
90	1.942885	1.982422
91	2.024139	2.06585[illegible]
92	2.110120	2.154383
93	2.201653	2.2489[illegible]4
94	2.299804	2.350684
95	2.405979	2.461[illegible]3
96	2.522095	2.582917
97	2.650870	2.718823
98	2.795352	2.873831
99	2.964999	3.056117
100	3.168169	3.280220
101	3.429193	3.578166
102	3.812832	4.047498

ERROR = 0.000256
ENTROPY = 6.374733

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 103

J	X	Y
52	-0.020876	0.000000
53	0.020876	0.041752
54	0.062641	0.083529
55	0.104442	0.125355
56	0.146304	0.167254
57	0.188252	0.209250
58	0.230310	0.251371
59	0.272505	0.293640
60	0.314863	0.336085
61	0.357409	0.378733
62	0.400172	0.421612
63	0.443181	0.464750
64	0.486465	0.508179
65	0.530055	0.551930
66	0.573983	0.596036
67	0.618284	0.640532
68	0.662993	0.685455
69	0.708149	0.730843
70	0.753792	0.776740
71	0.799964	0.823188
72	0.846712	0.870236
73	0.894085	0.917935
74	0.942138	0.966340
75	0.990926	1.015513
76	1.040515	1.065517
77	1.090972	1.116427
78	1.142373	1.168319
79	1.194800	1.221282
80	1.248347	1.275412
81	1.303115	1.330818
82	1.359219	1.387620
83	1.416787	1.445955
84	1.475966	1.505978
85	1.536922	1.567866
86	1.599845	1.631824
87	1.664955	1.698087
88	1.732511	1.766934
89	1.802813	1.838692
90	1.876222	1.913752
91	1.953171	1.992590
92	2.034188	2.075787
93	2.119928	2.164069
94	2.211215	2.258361
95	2.309114	2.359866
96	2.415028	2.470191
97	2.530874	2.591558
98	2.659365	2.727173
99	2.804545	2.881918
100	2.972865	3.063811
101	3.175668	3.287525
102	3.436263	3.585001
103	3.819341	4.053681

ERROR = 0.000252
ENTROPY = 6.388678

N = 104

J	X	Y
53	0.000000	0.020676
54	0.041358	0.062039
55	0.082739	0.103438
56	0.124167	0.144896
57	0.165667	0.186438
58	0.207262	0.228087
59	0.248977	0.269868
60	0.290837	0.311807
61	0.332868	0.353929
62	0.375096	0.396262
63	0.417547	0.438833
64	0.460252	0.481671
65	0.503238	0.524805
66	0.546536	0.568267
67	0.590179	0.612091
68	0.634200	0.656309
69	0.678635	0.700960
70	0.723521	0.746081
71	0.768898	0.791715
72	0.814810	0.837905
73	0.861301	0.884698
74	0.908422	0.932147
75	0.956226	0.980305
76	1.004770	1.029234
77	1.054116	1.078998
78	1.104334	1.129669
79	1.155498	1.181326
80	1.207691	1.234056
81	1.261005	1.287955
82	1.315543	1.343131
83	1.371418	1.399705
84	1.428759	1.457813
85	1.487712	1.517610
86	1.548442	1.579273
87	1.611139	1.643006
88	1.676025	1.709044
89	1.743354	1.777664
90	1.813429	1.849195
91	1.886610	1.924026
92	1.963329	2.002632
93	2.044113	2.085593
94	2.129615	2.173637
95	2.220661	2.267684
96	2.318311	2.368938
97	2.423970	2.479002
98	2.539550	2.600098
99	2.667761	2.735425
100	2.812644	2.889863
101	2.980640	3.071418
102	3.183083	3.294748
103	3.443254	3.591760
104	3.825779	4.059797

ERROR = 0.000247
ENTROPY = 6.402491

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 105

J	X	Y
53	-0.020482	0.000000
54	0.020482	0.040964
55	0.061458	0.081952
56	0.102468	0.122985
57	0.143536	0.164087
58	0.184685	0.205282
59	0.225938	0.246594
60	0.267320	0.288046
61	0.308855	0.329664
62	0.350568	0.371473
63	0.392486	0.413500
64	0.434636	0.455771
65	0.477044	0.498316
66	0.519740	0.541164
67	0.562755	0.584345
68	0.606119	0.627893
69	0.649867	0.671842
70	0.694034	0.716227
71	0.738657	0.761088
72	0.783776	0.806465
73	0.829434	0.852403
74	0.875675	0.898948
75	0.922550	0.946152
76	0.970110	0.994069
77	1.018414	1.042759
78	1.067523	1.092288
79	1.117507	1.142726
80	1.168440	1.194153
81	1.220404	1.246654
82	1.273491	1.300327
83	1.327803	1.355279
84	1.383454	1.411629
85	1.440572	1.469515
86	1.499303	1.529091
87	1.559811	1.590532
88	1.622288	1.654044
89	1.686952	1.719860
90	1.754059	1.788259
91	1.823912	1.859566
92	1.896869	1.934172
93	1.973361	2.012550
94	2.053915	2.095281
95	2.139185	2.183089
96	2.229993	2.276896
97	2.327399	2.377902
98	2.432806	2.487710
99	2.548124	2.608538
100	2.676061	2.743583
101	2.820650	2.897717
102	2.988328	3.078940
103	3.190416	3.301891
104	3.450169	3.598447
105	3.832147	4.065848

ERROR = 0.000242
ENTROPY = 6.416172

N = 106

J	X	Y
54	0.000000	0.020289
55	0.040584	0.060879
56	0.081190	0.101502
57	0.121842	0.142181
58	0.162560	0.182939
59	0.203368	0.223798
60	0.244290	0.264782
61	0.285349	0.305915
62	0.326568	0.347221
63	0.367974	0.388726
64	0.409591	0.430455
65	0.451445	0.472436
66	0.493566	0.514696
67	0.535980	0.557264
68	0.578718	0.600172
69	0.621812	0.643451
70	0.665294	0.687136
71	0.709200	0.731263
72	0.753566	0.775869
73	0.798433	0.820996
74	0.843842	0.866688
75	0.889839	0.912991
76	0.936473	0.959955
77	0.983796	1.007636
78	1.031865	1.056094
79	1.080743	1.105392
80	1.130497	1.155603
81	1.181203	1.206804
82	1.232943	1.259082
83	1.285807	1.312533
84	1.339899	1.367264
85	1.395330	1.423396
86	1.452230	1.481064
87	1.510743	1.540422
88	1.571034	1.601647
89	1.633294	1.664941
90	1.697741	1.730540
91	1.764630	1.798721
92	1.834264	1.869808
93	1.907001	1.944193
94	1.983270	2.022347
95	2.063599	2.104851
96	2.148640	2.192428
97	2.239213	2.285999
98	2.336380	2.386761
99	2.441539	2.496317
100	2.556600	2.616882
101	2.684265	2.751648
102	2.828566	2.905483
103	2.995931	3.086378
104	3.197667	3.308957
105	3.457009	3.605061
106	3.838448	4.071836

ERROR = 0.000238
ENTROPY = 6.429724

TABLE 1

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 107

J	X	Y
54	-0.020103	0.000000
55	0.020103	0.040205
56	0.060319	0.080432
57	0.100568	0.120703
58	0.140871	0.161039
59	0.181251	0.201462
60	0.221729	0.241996
61	0.262329	0.282662
62	0.303074	0.323485
63	0.343987	0.364488
64	0.385093	0.405697
65	0.426417	0.447137
66	0.467985	0.488834
67	0.509825	0.530816
68	0.551965	0.573113
69	0.594434	0.615754
70	0.637263	0.658772
71	0.680486	0.702200
72	0.724137	0.746074
73	0.768253	0.790432
74	0.812874	0.835315
75	0.858041	0.880766
76	0.903799	0.926832
77	0.950197	0.973562
78	0.997288	1.021013
79	1.045128	1.069242
80	1.093779	1.118315
81	1.143309	1.168303
82	1.193793	1.219283
83	1.245313	1.271343
84	1.297959	1.324576
85	1.351834	1.379092
86	1.407050	1.435009
87	1.463736	1.492463
88	1.522035	1.551608
89	1.582114	1.612620
90	1.644160	1.675701
91	1.708394	1.741087
92	1.775070	1.809053
93	1.844489	1.879925
94	1.917009	1.954092
95	1.993060	2.032027
96	2.073167	2.114307
97	2.157982	2.201657
98	2.248326	2.294995
99	2.345256	2.395518
100	2.450172	2.504826
101	2.564978	2.625131
102	2.692377	2.759623
103	2.836393	2.913163
104	3.003449	3.093734
105	3.204840	3.315946
106	3.463775	3.611605
107	3.844683	4.077761

ERROR = 0.000233
ENTROPY = 6.443151

N = 108

J	X	Y
55	0.000000	0.019917
56	0.039839	0.059761
57	0.079699	0.099637
58	0.119601	0.139566
59	0.159567	0.179569
60	0.199619	0.219668
61	0.239777	0.259885
62	0.280064	0.300243
63	0.320504	0.340765
64	0.361119	0.381474
65	0.401934	0.422394
66	0.442973	0.463552
67	0.484263	0.504974
68	0.525830	0.546686
69	0.567702	0.588718
70	0.609908	0.631099
71	0.652480	0.673862
72	0.695451	0.717039
73	0.738853	0.760667
74	0.782725	0.804783
75	0.827105	0.849427
76	0.872035	0.894643
77	0.917560	0.940477
78	0.963728	0.986979
79	1.010591	1.034204
80	1.058207	1.082210
81	1.106636	1.131063
82	1.155947	1.180832
83	1.206214	1.231596
84	1.257518	1.283440
85	1.309951	1.336461
86	1.363613	1.390765
87	1.418618	1.446471
88	1.475094	1.503716
89	1.533184	1.562652
90	1.593053	1.623455
91	1.654891	1.686327
92	1.718915	1.751503
93	1.785381	1.819259
94	1.854589	1.889919
95	1.926896	1.963873
96	2.002732	2.041591
97	2.082621	2.123652
98	2.167215	2.210778
99	2.257332	2.303886
100	2.354030	2.404174
101	2.458705	2.513237
102	2.573262	2.633286
103	2.700397	2.767508
104	2.844133	2.920759
105	3.010885	3.101011
106	3.211935	3.322859
107	3.470470	3.618080
108	3.850853	4.083625

ERROR = 0.000229
ENTROPY = 6.456453

TABLE 1

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 109

J	X	Y
55	-0.019737	0.000000
56	0.019737	0.039474
57	0.059221	0.078969
58	0.098736	0.118504
59	0.138303	0.158102
60	0.177942	0.197782
61	0.217674	0.237566
62	0.257522	0.277477
63	0.297506	0.317535
64	0.337649	0.357763
65	0.377975	0.398186
66	0.418506	0.438827
67	0.459268	0.479710
68	0.500287	0.520863
69	0.541587	0.562312
70	0.583199	0.604085
71	0.625149	0.646213
72	0.667470	0.688727
73	0.710193	0.731660
74	0.753353	0.775047
75	0.796987	0.818926
76	0.841132	0.863337
77	0.885830	0.908323
78	0.931127	0.953930
79	0.977070	1.000209
80	1.023711	1.047213
81	1.071107	1.095001
82	1.119319	1.143638
83	1.168415	1.193193
84	1.218469	1.243745
85	1.269562	1.295380
86	1.321786	1.348192
87	1.375240	1.402288
88	1.430038	1.457788
89	1.486307	1.514826
90	1.544192	1.573557
91	1.603856	1.634155
92	1.665488	1.696822
93	1.729307	1.761792
94	1.795567	1.829341
95	1.864567	1.899793
96	1.936665	1.973537
97	2.012289	2.051042
98	2.091965	2.132887
99	2.176340	2.219793
100	2.266234	2.312676
101	2.362704	2.412731
102	2.467142	2.521554
103	2.581452	2.641351
104	2.708329	2.775307
105	2.851789	2.928271
106	3.018240	3.108209
107	3.218954	3.329700
108	3.477094	3.624488
109	3.856958	4.089429

ERROR = 0.000225
ENTROPY = 6.469634

N = 110

J	X	Y
56	0.000000	0.019558
57	0.039121	0.058684
58	0.078261	0.097839
59	0.117442	0.137045
60	0.156683	0.176321
61	0.196005	0.215688
62	0.235428	0.255167
63	0.274973	0.294779
64	0.314662	0.334545
65	0.354517	0.374489
66	0.394561	0.414633
67	0.434817	0.455001
68	0.475309	0.495618
69	0.516063	0.536509
70	0.557105	0.577701
71	0.598462	0.619222
72	0.640163	0.661103
73	0.682239	0.703374
74	0.724721	0.746068
75	0.767644	0.789220
76	0.811044	0.832868
77	0.854959	0.877051
78	0.899432	0.921812
79	0.944505	0.967198
80	0.990228	1.013258
81	1.036652	1.060046
82	1.083833	1.107620
83	1.131833	1.156045
84	1.180718	1.205391
85	1.230563	1.255736
86	1.281450	1.307164
87	1.333468	1.359771
88	1.386718	1.413664
89	1.441313	1.468961
90	1.497380	1.525799
91	1.555062	1.584327
92	1.614525	1.644723
93	1.675956	1.707188
94	1.739572	1.771957
95	1.805629	1.839302
96	1.874426	1.909549
97	1.946318	1.983086
98	2.021735	2.060393
99	2.101199	2.142015
100	2.185360	2.228704
101	2.275035	2.321366
102	2.371279	2.421192
103	2.475485	2.529778
104	2.589552	2.649327
105	2.716174	2.783020
106	2.859361	2.935702
107	3.025516	3.115330
108	3.225899	3.336468
109	3.483648	3.630829
110	3.863002	4.095175

ERROR = 0.000221
ENTROPY = 6.482696

TABLE 1

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 111

J	X	Y
56	-0.019385	0.000000
57	0.019384	0.038769
58	0.058163	0.077557
59	0.096971	0.116384
60	0.135827	0.155270
61	0.174752	0.194234
62	0.213766	0.233297
63	0.252888	0.272479
64	0.292140	0.311801
65	0.331542	0.351284
66	0.371117	0.390950
67	0.410887	0.430823
68	0.450874	0.470925
69	0.491103	0.511282
70	0.531599	0.551917
71	0.572388	0.592859
72	0.613497	0.634135
73	0.654955	0.675775
74	0.696791	0.717808
75	0.739039	0.760269
76	0.781730	0.803192
77	0.824902	0.846613
78	0.868593	0.890574
79	0.912844	0.935115
80	0.957700	0.980284
81	1.003207	1.026130
82	1.049418	1.072706
83	1.096369	1.120071
84	1.144190	1.168289
85	1.192859	1.217430
86	1.242500	1.267571
87	1.293184	1.318797
88	1.345000	1.371203
89	1.398050	1.424897
90	1.452446	1.479995
91	1.508314	1.536633
92	1.565799	1.594964
93	1.625064	1.655163
94	1.686296	1.717430
95	1.749715	1.781999
96	1.815572	1.849145
97	1.884168	1.919191
98	1.955858	1.992525
99	2.031070	2.069615
100	2.110327	2.151039
101	2.194277	2.237514
102	2.283736	2.329957
103	2.379758	2.429559
104	2.483735	2.537911
105	2.597563	2.657216
106	2.723933	2.790650
107	2.866852	2.943054
108	3.032715	3.122376
109	3.232771	3.343166
110	3.490135	3.637104
111	3.868983	4.100862

ERROR = 0.000217
ENTROPY = 6.495640

N = 112

J	X	Y
57	0.000000	0.019211
58	0.038428	0.057644
59	0.076875	0.096105
60	0.115360	0.134614
61	0.153901	0.173189
62	0.192520	0.211850
63	0.231234	0.250618
64	0.270064	0.289511
65	0.309031	0.328550
66	0.348154	0.367758
67	0.387456	0.407154
68	0.426959	0.446763
69	0.466685	0.486606
70	0.506658	0.526709
71	0.546903	0.567096
72	0.587445	0.607794
73	0.628312	0.648830
74	0.669532	0.690234
75	0.711135	0.732036
76	0.753152	0.774269
77	0.795618	0.816967
78	0.838567	0.860157
79	0.882039	0.903910
80	0.926073	0.948237
81	0.970715	0.993[illegible]
82	1.016011	1.038[illegible]
83	1.062014	1.085[illegible]
84	1.108778	1.132358
85	1.156366	1.180373
86	1.204843	1.229313
87	1.254283	1.279254
88	1.304768	1.330282
89	1.356397	1.382492
90	1.409240	1.435989
91	1.463441	1.490892
92	1.519114	1.547336
93	1.576404	1.605472
94	1.635474	1.665476
95	1.696513	1.727549
96	1.759736	1.791923
97	1.825398	1.858872
98	1.893795	1.928720
99	1.965287	2.001[illegible]
100	2.040298	2.078[illegible]
101	2.119351	2.159960
102	2.203093	2.246226
103	2.292339	2.338453
104	2.388143	2.437833
105	2.491894	2.545955
106	2.605487	2.665019
107	2.731609	2.798198
108	2.874253	2.950325
109	3.039838	3.129348
110	3.239571	3.349794
111	3.496555	3.643316
112	3.874905	4.106494

ERROR = 0.000213
ENTROPY = 6.508469

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 113

J	X	Y
57	-0.019044	0.000000
58	0.019044	0.038088
59	0.057142	0.076195
60	0.095267	0.114339
61	0.133438	0.152538
62	0.171675	0.190812
63	0.209995	0.229179
64	0.248419	0.267659
65	0.286965	0.306271
66	0.325654	0.345036
67	0.364506	0.383975
68	0.403542	0.423109
69	0.442784	0.462460
70	0.482256	0.502051
71	0.521979	0.541907
72	0.561979	0.582051
73	0.602281	0.622511
74	0.642912	0.663313
75	0.683899	0.704486
76	0.725274	0.746062
77	0.767067	0.788072
78	0.809311	0.830551
79	0.852043	0.873535
80	0.895300	0.917065
81	0.939123	0.961181
82	0.983555	1.005933
83	1.028645	1.051369
84	1.074444	1.097552
85	1.121006	1.144486
86	1.168394	1.192302
87	1.216673	1.241044
88	1.265917	1.290789
89	1.316206	1.341623
90	1.367631	1.393640
91	1.420292	1.446944
92	1.474300	1.501656
93	1.529782	1.557908
94	1.586881	1.615854
95	1.645761	1.675667
96	1.706608	1.737548
97	1.769639	1.801730
98	1.835108	1.868486
99	1.903313	1.938140
100	1.974608	2.011077
101	2.049421	2.087766
102	2.128273	2.168781
103	2.211810	2.254840
104	2.300847	2.346355
105	2.396436	2.446016
106	2.499964	2.553912
107	2.613325	2.672738
108	2.739202	2.805666
109	2.881596	2.957525
110	3.046887	3.136248
111	3.246301	3.356355
112	3.502910	3.649466
113	3.880768	4.112069

ERROR = 0.000209
ENTROPY = 6.521185

N = 114

J	X	Y
58	-0.000001	0.018876
59	0.037758	0.056640
60	0.075535	0.094430
61	0.113348	0.132266
62	0.151216	0.170165
63	0.189155	0.208146
64	0.227186	0.246227
65	0.265327	0.284427
66	0.303597	0.322766
67	0.342015	0.361264
68	0.380603	0.399942
69	0.419381	0.438820
70	0.458370	0.477920
71	0.497593	0.517265
72	0.537072	0.556879
73	0.576833	0.596787
74	0.616900	0.637014
75	0.657301	0.677587
76	0.698062	0.718536
77	0.739214	0.759891
78	0.780787	0.801683
79	0.822815	0.843947
80	0.865334	0.886720
81	0.908381	0.930041
82	0.951996	0.973952
83	0.996224	1.018497
84	1.041112	1.063727
85	1.086710	1.109694
86	1.133075	1.156456
87	1.180267	1.204077
88	1.228351	1.252626
89	1.277402	1.302179
90	1.327501	1.352822
91	1.378736	1.404649
92	1.431207	1.457765
93	1.485027	1.512288
94	1.540321	1.568353
95	1.597232	1.626111
96	1.655924	1.685736
97	1.716583	1.747429
98	1.779426	1.811422
99	1.844706	1.877989
100	1.912720	1.947451
101	1.983822	2.020194
102	2.058440	2.096687
103	2.137095	2.177502
104	2.220430	2.263358
105	2.309261	2.355165
106	2.404638	2.454111
107	2.507946	2.561782
108	2.621079	2.680375
109	2.746715	2.813055
110	2.888851	2.964647
111	3.053862	3.143076
112	3.252962	3.362848
113	3.509201	3.655553
114	3.886572	4.117590

ERROR = 0.000206
ENTROPY = 6.533790

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 115

J	X	Y
58	-0.018716	0.000000
59	0.018716	0.037431
60	0.056156	0.074880
61	0.093622	0.112364
62	0.131132	0.149901
63	0.168704	0.187508
64	0.206356	0.225204
65	0.244105	0.263007
66	0.281971	0.300935
67	0.319972	0.339008
68	0.358127	0.377246
69	0.396458	0.415669
70	0.434983	0.454297
71	0.473725	0.493153
72	0.512706	0.532258
73	0.551948	0.571637
74	0.591475	0.611313
75	0.631313	0.651313
76	0.671488	0.691663
77	0.712028	0.732393
78	0.752962	0.773531
79	0.794321	0.815110
80	0.836137	0.857165
81	0.878448	0.899731
82	0.921289	0.942845
83	0.964702	0.986556
84	1.008729	1.030902
85	1.053419	1.075935
86	1.098821	1.121707
87	1.144992	1.168276
88	1.191991	1.215706
89	1.239885	1.264065
90	1.288747	1.313430
91	1.338658	1.363886
92	1.389706	1.415526
93	1.441991	1.468457
94	1.495626	1.522795
95	1.550735	1.578675
96	1.607462	1.636249
97	1.665970	1.695690
98	1.726444	1.757198
99	1.789101	1.821005
100	1.854195	1.887385
101	1.922021	1.956658
102	1.992934	2.029211
103	2.067361	2.105510
104	2.145820	2.186130
105	2.228957	2.271784
106	2.317585	2.363386
107	2.412753	2.462119
108	2.515845	2.569571
109	2.628752	2.687933
110	2.754150	2.820368
111	2.896032	2.971697
112	3.060767	3.149836
113	3.259557	3.369278
114	3.515430	3.661582
115	3.892320	4.123059

ERROR = 0.000202
ENTROPY = 6.546286

N = 116

J	X	Y
59	0.000000	0.018555
60	0.037113	0.055672
61	0.074244	0.092816
62	0.111409	0.130002
63	0.148625	0.167248
64	0.185910	0.204571
65	0.223281	0.241990
66	0.260756	0.279522
67	0.298354	0.317186
68	0.336093	0.355001
69	0.373993	0.392985
70	0.412072	0.431159
71	0.450352	0.469544
72	0.488853	0.508162
73	0.527597	0.547033
74	0.566607	0.586182
75	0.605907	0.625632
76	0.645521	0.665410
77	0.685476	0.705542
78	0.725799	0.746057
79	0.766520	0.786983
80	0.807669	0.828355
81	0.849279	0.870204
82	0.891385	0.912567
83	0.934025	0.955488
84	0.977239	0.998995
85	1.021071	1.043146
86	1.065566	1.087986
87	1.110776	1.133567
88	1.156757	1.179947
89	1.203568	1.227188
90	1.251275	1.275361
91	1.299951	1.324541
92	1.349677	1.374813
93	1.400542	1.426271
94	1.452645	1.479019
95	1.506098	1.533176
96	1.561026	1.588875
97	1.617572	1.646268
98	1.675897	1.705527
99	1.736190	1.766853
100	1.798665	1.830478
101	1.863576	1.896673
102	1.931217	1.965761
103	2.001944	2.038127
104	2.076181	2.114236
105	2.154449	2.194662
106	2.237390	2.280119
107	2.325818	2.371518
108	2.420780	2.470042
109	2.523659	2.577276
110	2.636344	2.695411
111	2.761508	2.827605
112	2.903139	2.978674
113	3.067601	3.156527
114	3.266085	3.375643
115	3.521597	3.667551
116	3.898013	4.128474

ERROR = 0.000199
ENTROPY = 6.558674

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 117

J	X	Y
59	-0.018398	0.000000
60	0.018398	0.036797
61	0.055203	0.073610
62	0.092033	0.110457
63	0.128905	0.147353
64	0.165835	0.184317
65	0.202841	0.221365
66	0.239939	0.258514
67	0.277149	0.295783
68	0.314486	0.333189
69	0.351970	0.370751
70	0.389620	0.408489
71	0.427455	0.446421
72	0.465495	0.484569
73	0.503761	0.522953
74	0.542274	0.561596
75	0.581058	0.600520
76	0.620135	0.639750
77	0.659531	0.679311
78	0.699271	0.719230
79	0.739382	0.759534
80	0.779894	0.800254
81	0.820838	0.841422
82	0.862246	0.883070
83	0.904152	0.925235
84	0.946595	0.967956
85	0.989615	1.011274
86	1.033254	1.055233
87	1.077559	1.099884
88	1.122581	1.145277
89	1.168374	1.191472
90	1.215000	1.238529
91	1.262524	1.286519
92	1.311019	1.335518
93	1.360564	1.385609
94	1.411249	1.436888
95	1.463172	1.489457
96	1.516446	1.543436
97	1.571196	1.598956
98	1.627564	1.656171
99	1.685711	1.715252
100	1.745825	1.776399
101	1.808121	1.839844
102	1.872851	1.905858
103	1.940311	1.974763
104	2.010854	2.046944
105	2.084905	2.122866
106	2.162984	2.203102
107	2.245733	2.288364
108	2.333964	2.379563
109	2.428723	2.477882
110	2.531392	2.584902
111	2.643857	2.702811
112	2.768789	2.834767
113	2.910174	2.985580
114	3.074366	3.163151
115	3.272548	3.381945
116	3.527703	3.673462
117	3.903650	4.133838

ERROR = 0.000195
ENTROPY = 6.570957

N = 118

J	X	Y
60	0.000000	0.018243
61	0.036489	0.054736
62	0.072995	0.091254
63	0.109533	0.127812
64	0.146120	0.164428
65	0.182772	0.201117
66	0.219506	0.237896
67	0.256340	0.274783
68	0.293289	0.311796
69	0.330373	0.348951
70	0.367609	0.386267
71	0.405015	0.423764
72	0.442612	0.461460
73	0.480418	0.499376
74	0.518454	0.537533
75	0.556743	0.575953
76	0.595305	0.614658
77	0.634165	0.653672
78	0.673347	0.693021
79	0.712877	0.732732
80	0.752781	0.772831
81	0.793089	0.813348
82	0.833832	0.854316
83	0.875042	0.895767
84	0.916753	0.937738
85	0.959003	0.980267
86	1.001831	1.023395
87	1.045282	1.067168
88	1.089400	1.111633
89	1.134237	1.156842
90	1.179848	1.202854
91	1.226293	1.249731
92	1.273637	1.297542
93	1.321952	1.346363
94	1.371320	1.396277
95	1.421828	1.447379
96	1.473575	1.499772
97	1.526674	1.553575
98	1.581248	1.608921
99	1.637441	1.665960
100	1.695413	1.724866
101	1.755351	1.785837
102	1.817471	1.849105
103	1.882023	1.914941
104	1.949304	1.983667
105	2.019666	2.055666
106	2.093535	2.131403
107	2.171427	2.211451
108	2.253986	2.296522
109	2.342023	2.387524
110	2.436582	2.485639
111	2.539044	2.592448
112	2.651292	2.710136
113	2.775997	2.841858
114	2.917137	2.992417
115	3.081064	3.169710
116	3.278947	3.388185
117	3.533750	3.679315
118	3.909234	4.139152

ERROR = 0.000192
ENTROPY = 6.583136

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 119

J	X	Y
60	-0.018092	0.000000
61	0.018092	0.036183
62	0.054283	0.072382
63	0.090497	0.108613
64	0.126752	0.144891
65	0.163062	0.181233
66	0.199444	0.217655
67	0.235914	0.254173
68	0.272489	0.290805
69	0.309186	0.327567
70	0.346022	0.364478
71	0.383016	0.401554
72	0.420185	0.438816
73	0.457549	0.476282
74	0.495127	0.513972
75	0.532940	0.551907
76	0.571008	0.590109
77	0.609354	0.628600
78	0.648002	0.667404
79	0.686975	0.706546
80	0.726299	0.746052
81	0.766001	0.785950
82	0.806110	0.826269
83	0.846656	0.867042
84	0.887671	0.908300
85	0.929191	0.950081
86	0.971251	0.992422
87	1.013893	1.035364
88	1.057159	1.078953
89	1.101094	1.123236
90	1.145750	1.168265
91	1.191182	1.214098
92	1.237448	1.260798
93	1.284615	1.308433
94	1.332755	1.357078
95	1.381948	1.406818
96	1.432283	1.457747
97	1.483857	1.509968
98	1.536783	1.563598
99	1.591185	1.618772
100	1.647205	1.675639
101	1.705005	1.734371
102	1.764770	1.795169
103	1.826716	1.858263
104	1.891094	1.923924
105	1.958199	1.992473
106	2.028383	2.064293
107	2.102071	2.139849
108	2.179780	2.219712
109	2.262153	2.304594
110	2.349998	2.395402
111	2.444359	2.493317
112	2.546617	2.599917
113	2.658652	2.717387
114	2.783132	2.848876
115	2.924031	2.999187
116	3.087695	3.176204
117	3.285284	3.394365
118	3.539739	3.685113
119	3.914764	4.144416

ERROR = 0.000189
ENTROPY = 6.595213

N = 120

J	X	Y
61	0.000000	0.017941
62	0.035886	0.053831
63	0.071787	0.089744
64	0.107720	0.125695
65	0.143698	0.161701
66	0.179739	0.197777
67	0.215858	0.233939
68	0.252071	0.270203
69	0.288395	0.306586
70	0.324845	0.343105
71	0.361441	0.379777
72	0.398198	0.416620
73	0.435136	0.453652
74	0.472273	0.490893
75	0.509628	0.528363
76	0.547222	0.566081
77	0.585075	0.604070
78	0.623210	0.642351
79	0.661650	0.680949
80	0.700419	0.719883
81	0.739542	0.759195
82	0.779045	0.798896
83	0.818959	0.839022
84	0.859312	0.879603
85	0.900138	0.920673
86	0.941470	0.962267
87	0.983345	1.004424
88	1.025804	1.047184
89	1.068888	1.090592
90	1.112644	1.134696
91	1.157123	1.179549
92	1.202378	1.225207
93	1.248469	1.271732
94	1.295463	1.319194
95	1.343431	1.367668
96	1.392452	1.417237
97	1.442616	1.467995
98	1.494020	1.520046
99	1.546776	1.573507
100	1.601009	1.628511
101	1.656860	1.685209
102	1.714490	1.743772
103	1.774085	1.804399
104	1.835860	1.867320
105	1.900066	1.932810
106	1.966997	2.001164
107	2.037006	2.072829
108	2.110517	2.148205
109	2.188045	2.227885
110	2.270233	2.312538
111	2.357839	2.403196
112	2.452056	2.500915
113	2.554113	2.607310
114	2.665937	2.724564
115	2.790195	2.855825
116	2.930857	3.005889
117	3.094262	3.182634
118	3.291559	3.400485
119	3.545671	3.690856
120	3.920244	4.149631

ERROR = 0.000186
ENTROPY = 6.607190

TABLE 1

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 121

J	X	Y
61	-0.017795	0.000000
62	0.017795	0.035590
63	0.053392	0.071195
64	0.089012	0.106830
65	0.124670	0.142510
66	0.160380	0.178251
67	0.196159	0.214067
68	0.232022	0.249976
69	0.267984	0.285993
70	0.304063	0.322133
71	0.340274	0.358415
72	0.376634	0.394854
73	0.413161	0.431469
74	0.449873	0.468278
75	0.486788	0.505299
76	0.523926	0.542553
77	0.561306	0.580059
78	0.598950	0.617840
79	0.636878	0.655917
80	0.675115	0.694313
81	0.713684	0.733054
82	0.752610	0.772165
83	0.791920	0.811674
84	0.831642	0.851610
85	0.871807	0.892003
86	0.912446	0.932888
87	0.953594	0.974300
88	0.995288	1.016276
89	1.037566	1.058857
90	1.080473	1.102089
91	1.124053	1.146018
92	1.168357	1.190697
93	1.213439	1.236182
94	1.259360	1.282537
95	1.306183	1.329829
96	1.353981	1.378133
97	1.402834	1.427535
98	1.452830	1.478135
99	1.504067	1.530009
100	1.556657	1.583304
101	1.610723	1.638141
102	1.666407	1.694672
103	1.723870	1.753068
104	1.783298	1.813527
105	1.844904	1.876281
106	1.908941	1.941600
107	1.975701	2.009803
108	2.045538	2.081273
109	2.118873	2.156473
110	2.196224	2.235974
111	2.278230	2.320486
112	2.365700	2.410914
113	2.459675	2.508436
114	2.561532	2.614629
115	2.673150	2.731670
116	2.797188	2.862705
117	2.937616	3.012526
118	3.100764	3.189003
119	3.297775	3.406547
120	3.551546	3.696545
121	3.925672	4.154798

ERROR = 0.000183
ENTROPY = 6.619068

N = 122

J	X	Y
62	0.000000	0.017649
63	0.035302	0.052955
64	0.070619	0.088283
65	0.105965	0.123648
66	0.141356	0.159064
67	0.176805	0.194547
68	0.212329	0.230111
69	0.247943	0.265774
70	0.283661	0.301549
71	0.319501	0.337453
72	0.355478	0.373503
73	0.391609	0.409715
74	0.427911	0.446107
75	0.464402	0.482698
76	0.501101	0.519505
77	0.538026	0.556548
78	0.575198	0.593847
79	0.612636	0.631424
80	0.650363	0.669301
81	0.688401	0.707500
82	0.726774	0.746047
83	0.765507	0.784967
84	0.804627	0.824287
85	0.844162	0.864037
86	0.884142	0.904247
87	0.924599	0.944951
88	0.965567	0.986183
89	1.007082	1.027982
90	1.049185	1.070388
91	1.091917	1.113446
92	1.135324	1.157203
93	1.179457	1.201711
94	1.224370	1.247028
95	1.270121	1.293215
96	1.316777	1.340340
97	1.364409	1.388478
98	1.413096	1.437714
99	1.462927	1.488140
100	1.514000	1.539860
101	1.566426	1.592991
102	1.620328	1.647665
103	1.675848	1.704031
104	1.733147	1.762263
105	1.792410	1.822557
106	1.853851	1.885145
107	1.917720	1.950296
108	1.984313	2.018330
109	2.053979	2.089628
110	2.127142	2.164655
111	2.204317	2.243979
112	2.286144	2.328310
113	2.373431	2.418552
114	2.467217	2.515882
115	2.568878	2.621874
116	2.680290	2.738706
117	2.804112	2.869518
118	2.944308	3.019098
119	3.107204	3.195310
120	3.303931	3.412551
121	3.557366	3.702182
122	3.931050	4.159918

ERROR = 0.000180
ENTROPY = 6.630849

TABLE I

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 123

J	X	Y
62	-0.017508	0.000000
63	0.017508	0.035015
64	0.052530	0.070045
65	0.087575	0.105104
66	0.122655	0.140206
67	0.157785	0.175365
68	0.192981	0.210597
69	0.228256	0.245916
70	0.263627	0.281338
71	0.299108	0.316877
72	0.334714	0.352551
73	0.370463	0.388375
74	0.406370	0.424366
75	0.442453	0.460541
76	0.478729	0.496918
77	0.515217	0.533515
78	0.551934	0.570353
79	0.588901	0.607450
80	0.626139	0.644828
81	0.663668	0.682509
82	0.701512	0.720515
83	0.739693	0.758872
84	0.778238	0.797604
85	0.817172	0.836740
86	0.856524	0.876307
87	0.896322	0.916338
88	0.936600	0.956866
89	0.977392	0.997930
90	1.018732	1.039545
91	1.060662	1.081779
92	1.103223	1.124667
93	1.146461	1.168255
94	1.190426	1.212596
95	1.235171	1.257747
96	1.280757	1.303768
97	1.327249	1.350730
98	1.374717	1.398705
99	1.423242	1.447779
100	1.472911	1.498043
101	1.523822	1.549601
102	1.576086	1.602571
103	1.629827	1.657083
104	1.685186	1.713288
105	1.742323	1.771358
106	1.801424	1.831490
107	1.862702	1.893914
108	1.926407	1.958900
109	1.992834	2.026767
110	2.062332	2.097897
111	2.135325	2.172753
112	2.212327	2.251902
113	2.293978	2.336054
114	2.381083	2.426112
115	2.474683	2.523253
116	2.576151	2.629048
117	2.687360	2.745673
118	2.810969	2.876265
119	2.950936	3.025608
120	3.113583	3.201558
121	3.310029	3.418500
122	3.563133	3.707766
123	3.936379	4.164992

ERROR = 0.000177
ENTROPY = 6.642534

N = 124

J	X	Y
63	0.000000	0.017367
64	0.034737	0.052107
65	0.069488	0.086869
66	0.104267	0.121665
67	0.139088	0.156511
68	0.173966	0.191420
69	0.208914	0.226408
70	0.243947	0.261487
71	0.279081	0.296675
72	0.314330	0.331985
73	0.349709	0.367434
74	0.385236	0.403037
75	0.420925	0.438812
76	0.456793	0.474775
77	0.492859	0.510943
78	0.529140	0.547336
79	0.565654	0.583972
80	0.602422	0.620871
81	0.639463	0.658054
82	0.676799	0.695543
83	0.714452	0.733361
84	0.752446	0.771532
85	0.790806	0.810081
86	0.829558	0.849035
87	0.868730	0.888422
88	0.908351	0.928278
89	0.948454	0.968638
90	0.989072	1.009544
91	1.030241	1.050966
92	1.072001	1.093034
93	1.114394	1.135754
94	1.157465	1.179177
95	1.201265	1.223354
96	1.245847	1.268341
97	1.291271	1.314201
98	1.337601	1.361001
99	1.384908	1.408816
100	1.433273	1.457730
101	1.482782	1.507835
102	1.533535	1.559235
103	1.585640	1.612045
104	1.639222	1.666399
105	1.694422	1.722445
106	1.751400	1.780355
107	1.810341	1.840327
108	1.871459	1.902590
109	1.935002	1.967414
110	2.001265	2.035117
111	2.070599	2.106081
112	2.143424	2.180767
113	2.220256	2.259744
114	2.301732	2.343720
115	2.388659	2.433598
116	2.482074	2.530551
117	2.583351	2.636151
118	2.694361	2.752572
119	2.817759	2.882947
120	2.957501	3.032055
121	3.119901	3.207746
122	3.316069	3.424392
123	3.568845	3.713299
124	3.941659	4.170020

ERROR = 0.000174
ENTROPY = 6.654126

TABLE 1

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 125

J	X	Y
63	-0.017230	0.000000
64	0.017230	0.034459
65	0.051696	0.068933
66	0.086183	0.103433
67	0.120704	0.137975
68	0.155273	0.172571
69	0.189904	0.207237
70	0.224611	0.241986
71	0.259409	0.276832
72	0.294312	0.311791
73	0.329334	0.346878
74	0.364492	0.382107
75	0.399801	0.417495
76	0.435277	0.453058
77	0.470936	0.488814
78	0.506796	0.524779
79	0.542875	0.560971
80	0.579191	0.597410
81	0.615763	0.634116
82	0.652612	0.671109
83	0.689759	0.708410
84	0.727226	0.746043
85	0.765037	0.784031
86	0.803216	0.822400
87	0.841789	0.861178
88	0.880785	0.900392
89	0.920232	0.940072
90	0.960163	0.980253
91	1.000610	1.020968
92	1.041612	1.062255
93	1.083205	1.104155
94	1.125433	1.146711
95	1.168341	1.189971
96	1.211979	1.233987
97	1.256400	1.278814
98	1.301664	1.324514
99	1.347835	1.371156
100	1.394985	1.418814
101	1.443192	1.467570
102	1.492545	1.517519
103	1.543141	1.568762
104	1.595090	1.621417
105	1.648516	1.675614
106	1.703559	1.731504
107	1.760388	1.789257
108	1.819164	1.849071
109	1.880093	1.911176
110	1.943507	1.975839
111	2.009610	2.043381
112	2.078780	2.114180
113	2.151440	2.188700
114	2.228104	2.267508
115	2.309340	2.351310
116	2.396159	2.441009
117	2.489393	2.537778
118	2.590482	2.643186
119	2.701295	2.759404
120	2.824484	2.889565
121	2.964003	3.038441
122	3.126159	3.213877
123	3.322054	3.430231
124	3.574506	3.718781
125	3.946893	4.175004

ERROR = 0.000171
ENTROPY = 6.665625

N = 126

J	X	Y
64	0.000000	0.017093
65	0.034189	0.051286
66	0.068393	0.085499
67	0.102622	0.119746
68	0.136892	0.154039
69	0.171216	0.188393
70	0.205607	0.222821
71	0.240080	0.257338
72	0.274647	0.291957
73	0.309325	0.326693
74	0.344127	0.361561
75	0.379068	0.396576
76	0.414165	0.431754
77	0.449432	0.467111
78	0.484887	0.502663
79	0.520546	0.538429
80	0.556427	0.574426
81	0.592549	0.610672
82	0.628930	0.647188
83	0.665592	0.683995
84	0.702553	0.721112
85	0.739838	0.758561
86	0.777469	0.796374
87	0.815470	0.834567
88	0.853869	0.873170
89	0.892691	0.912209
90	0.931968	0.951713
91	0.971730	0.991713
92	1.012011	1.032248
93	1.052847	1.073360
94	1.094277	1.115096
95	1.136343	1.157541
96	1.179091	1.200641
97	1.222569	1.244498
98	1.266833	1.289167
99	1.311939	1.334711
100	1.357954	1.381197
101	1.404949	1.428700
102	1.453001	1.477302
103	1.502200	1.527097
104	1.552642	1.578187
105	1.604437	1.630687
106	1.657709	1.684731
107	1.712599	1.740468
108	1.769266	1.798065
109	1.827895	1.857722
110	1.888698	1.919672
111	1.951925	1.984178
112	2.017869	2.051560
113	2.086879	2.122198
114	2.159376	2.196554
115	2.235874	2.275199
116	2.317009	2.358825
117	2.403586	2.448347
118	2.496641	2.544934
119	2.597543	2.650152
120	2.708162	2.766171
121	2.831145	2.896120
122	2.970444	3.044768
123	3.132360	3.219951
124	3.327984	3.436016
125	3.580115	3.724215
126	3.952079	4.179943

ERROR = 0.000169
ENTROPY = 6.677034

TABLE 1

MAX'S QUANTIZER PARAMETERS FOR THE NORMAL DISTRIBUTION (CONT'D.)

N = 127

J	X	Y
64	-0.016961	0.000000
65	0.016960	0.033921
66	0.050888	0.067855
67	0.084835	0.101815
68	0.118814	0.135814
69	0.152840	0.169865
70	0.186924	0.203983
71	0.221081	0.238180
72	0.255325	0.272470
73	0.289668	0.306867
74	0.324126	0.341385
75	0.358712	0.376040
76	0.393443	0.410845
77	0.428332	0.445818
78	0.463396	0.480973
79	0.498650	0.516328
80	0.534113	0.551899
81	0.569801	0.587704
82	0.605733	0.623762
83	0.641927	0.660093
84	0.678404	0.696716
85	0.715185	0.733654
86	0.752291	0.770928
87	0.789746	0.808563
88	0.827573	0.846584
89	0.865800	0.885016
90	0.904453	0.923890
91	0.943563	0.963235
92	0.983159	1.003083
93	1.023276	1.043470
94	1.063950	1.084431
95	1.105220	1.126009
96	1.147127	1.168246
97	1.189717	1.211189
98	1.233039	1.254890
99	1.277147	1.299404
100	1.322099	1.344794
101	1.367961	1.391127
102	1.414802	1.438478
103	1.462703	1.486928
104	1.511750	1.536571
105	1.562040	1.587509
106	1.613684	1.639859
107	1.666805	1.693751
108	1.721543	1.749335
109	1.778058	1.806781
110	1.836534	1.866287
111	1.897184	1.928081
112	1.960256	1.992431
113	2.026044	2.059656
114	2.094896	2.130135
115	2.167232	2.204329
116	2.243566	2.282804
117	2.324534	2.366265
118	2.410940	2.455614
119	2.503818	2.552021
120	2.604536	2.657052
121	2.714963	2.772874
122	2.837744	2.902614
123	2.976825	3.051036
124	3.138503	3.225970
125	3.333859	3.441749
126	3.585674	3.729599
127	3.957220	4.184840

ERROR = 0.000166
ENTROPY = 6.688352

N = 128

J	X	Y
65	-0.000001	0.016828
66	0.033659	0.050490
67	0.067331	0.084172
68	0.101029	0.117886
69	0.134765	0.151644
70	0.168552	0.185460
71	0.202404	0.219347
72	0.236333	0.253318
73	0.270353	0.287387
74	0.304477	0.321567
75	0.338720	0.355874
76	0.373097	0.390320
77	0.407620	0.424921
78	0.442307	0.459693
79	0.477172	0.494651
80	0.512231	0.529812
81	0.547502	0.565192
82	0.583001	0.600810
83	0.618747	0.636684
84	0.654758	0.672833
85	0.691055	0.709277
86	0.727658	0.746039
87	0.764589	0.783139
88	0.801871	0.820602
89	0.839528	0.858454
90	0.877587	0.896719
91	0.916074	0.935428
92	0.955019	0.974609
93	0.994453	1.014296
94	1.034409	1.054523
95	1.074924	1.095326
96	1.116037	1.136747
97	1.157788	1.178828
98	1.200223	1.221617
99	1.243391	1.265165
100	1.287346	1.309527
101	1.332146	1.354766
102	1.377857	1.400948
103	1.424548	1.448148
104	1.472299	1.496450
105	1.521196	1.545943
106	1.571338	1.596733
107	1.622833	1.648933
108	1.675805	1.702677
109	1.730394	1.758111
110	1.786759	1.815407
111	1.845085	1.874762
112	1.905583	1.936404
113	1.968503	2.000601
114	2.034136	2.067671
115	2.102832	2.137993
116	2.175010	2.212027
117	2.251183	2.290339
118	2.331986	2.373634
119	2.418222	2.462811
120	2.510926	2.559040
121	2.611463	2.663886
122	2.721700	2.779514
123	2.844280	2.909047
124	2.983146	3.057246
125	3.144589	3.231933
126	3.339681	3.447430
127	3.591183	3.734936
128	3.962315	4.189694

ERROR = 0.000163
ENTROPY = 6.699583

APPENDIX A

PROGRAM LISTING TO SOLVE FOR LLOYD-MAX QUANTIZER PARAMETERS BY THE METHOD OF SUCCESSIVE SUBSTITUTION

```
C THIS PROGRAM CALCULATES LLOYD-MAX QUANTIZER PARAMETERS BY THE METHOD
C OF SUCCESSIVE SUBSTITUTION FOR THE NORMAL DISTRIBUTION OF ZERO MEAN
C AND UNIT VARIANCE
C The INPUT TO THE PROGRAM IS
C    (1)     THE NUMBER OF QUANTIZATION LEVELS    N
C    (2)     THE MAXIMUM NUMBER OF ITERATIONS     M
C    (2)     THE ACCURACY                         AP
C              ******************************
       REAL*8 X(199),T(199),XX(199),TT(199),C ,DELTA,AP(199),AP
      1,ERROR,ENTROP
       INTEGER K,N,I,P,N1,N2,N3,M
       C=DSQRT(00.50D0/DATAN(1.0D0))
C      DO 99 N=110,110
C*************************************************************
C   INPUT THE NUMBER OF QUANTIZATION LEVELS
       N=100
       WRITE(9,65)N
       WRITE(9,66)
       WRITE(9,67)
       WRITE(9,66)
C*************************************************************
C     INITIALIZATION OF THE QUANTIZER PARAMETERS
C
       DELTA=0.0150D0*DFLOAT(N)
       XX(1)=-10.50000D0
       TT(1)=-5.50000D0
       X(1)=XX(1)
       T(1)=TT(1)
       DO 50  L=2,N
            TT(L)=TT(L-1)-DELTA
            XX(L)=(TT(I)+TT(I-1))/2.0D0
            X(L)=XX(L)
            T(L)=TT(L)
 50    CONTINUE
C*****************************************************
C     BEGINING OF THE ITERATIONS
c      M = MAXIMUM NUMBER OF ITERATIONS
       M = 1050
       K=0
 5     K=K+1
       IF (K .GT. M) GO TO 10
        IF (K .GT. 1)X(N)=XX(N)
        IF (K .GT. 1)T(N)=TT(N)
       TT(1)=-C*DEXP(-XX(2)*XX(2)/2.0D0)/(DERFC(-10.0D0)-
      1DERFC(XX(2)/DSQRT(2.0D0)))
       T(1)=TT(1)
       IF ( N .EQ. 2 ) GO TO 17
        DO 15  P=2,N-1
            XX(P)=(T(P)+T(P-1))/2.0D0
            X(P)=XX(P)
            TT(P)=DEXP(-X(P)*X(P)/2.0D0)-DEXP(-X(P+1)*X(P+1)/2.0D0)
            TT(P)=TT(P)*C/(DERFC(X(P)/DSQRT(2.0L0))-DERFC(X(P+1)/DSQRT(2.0
      1     0D0)))
            T(P)=TT(P)
 15            CONTINUE
 17            CONTINUE
          XX(N)=(TT(N)+T(N-1))/2.0D0
       TT(N)=DEXP(-XX(N)*XX(N)/2.0D0)*C/DERFC(XX(N)/DSQRT(2.0D0))
       X(N)=XX(N)
       T(N)=TT(N)
```

```
      N2=IDINT(DFLOAT((N+2)/2))
      N1=IDINT(DFLOAT((N+1)/2))
C*****************************************************
C     CHECKING THE PRECISION OF THE SOLUTION
c     AP = REQUIRED ACCURACY
      AP=0.10D-6
       IF((MOD(N,2) .EQ. 0).AND.(DABS(X(N2)).GT. AP))GO TO 5
       IF((MOD(N+1,2) .EQ. 0).AND. (DABS(T(N1)).GT. AP))GO TO 5
         CONTINUE
 10     CONTINUE
C*****************************************************
C     OUTPUT RESULTS
       IF (MOD(N,2) .EQ. 0)N3=N2
       IF (MOD(N+1,2) .EQ. 0)N3=N1
        WRITE(6,60) K
        DO 120 J=1,N3
            IF (J .EQ. 1)
     1     WRITE(9,71)J, T(J)
            IF (J .GT. 1)
     1     WRITE(9,61)J, X(J),T(J)
 120    CONTINUE
        X(N+1)=10.0D0
        X(1)=-10.0D0
        ERROR=0.0D0
        ENTROP=0.0D0
        DO 222 I=1,N
                AP(I)=DERFC(X(I)/DSQRT(2.0D0))-DERFC(X(I+1)/DSQRT(2.0D0))
                AP(I)=AP(I)/2.0D0
                ERROR=ERROR+AP(I)*T(I)**2
                ENTROP=ENTROP-AP(I)*DLOG(AP(I))/DLOG(2.0D0)
 222    CONTINUE
        ERROR=1.0D0-ERROR
        WRITE(9,66)
        WRITE(9,62) ERROR
        WRITE(9,66)
        WRITE(9,63) ENTROP
        WRITE(9,66)
        WRITE(6,72) K
        WRITE(9,90)
        WRITE(9,66)
C99    CONTINUE
 65     FORMAT(3X,'  N = ',I7)
 66     FORMAT(3X,'--------------------------')
 67     FORMAT(3X,' J        X          Y      ')
 60     FORMAT(1X,I7,8(1X,F6.4))
 90     FORMAT(2X,'==========================================')
 61     FORMAT(1X,I4, 2(2X,F9.6))
 71     FORMAT(1X,I4,11X, 2(2X,F9.6))
 62     FORMAT(7X,'ERROR   =', 2(1X,F9.6))
 72     FORMAT(3X,'# ITERATIONS = ',I7 )
 63     FORMAT(7X,'ENTROPY =', 2(1X,F9.6))
        STOP
        END
```

1. Lloyd, S. P., "Least Squares Quantization in PCM," Unpublished Bell Laboratories manuscript, July 31, 1957; also in *IEEE Trans. on Inform. Theory*, vol. IT-28, pp. 129-137, 1982.

2. Max,J., "Quantization for Minimum Distortion", *IRE Trans. on Inform. Theory*, vol. IT-6,pp. 7-13,1960.

3. Pearson ,C. E.,Numerical Methods in Engineering and Science, pp.11-12 and 49-50, Van Nostrand Reinhold Company, New York, 1986.

4. Kassam, S. A., "Optimal Quantization for Signal Detection", *IEEE, Trans. on Communication*, vol. COM-25, No. 5,May 1977,pp. 479-484.

5. Al-Bassiouni, A.M., *Optimum Signal Processing in Distributed Sensor Systems*, Ph. D. Dissertation at the Naval Postgraduate School, Dec. 1987.

6. Wood, C. R., "On Optimum Quantization", *IEEE Trans. on Information Theory*, vol. IT-15, No.2, March 1969.

7. Velichkin, A. I., "Optimum Characteristics of Quantizers," *Telecommunication Radio Eng. (USSR)*, vol. 18, Feb. 1963, pp.1-7.

8. Garmash,V. A., "The Quantization of Signals with Non-uniform Steps," *Telecommunications*, No. 10, pp. 10-12, Oct., 1957.

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